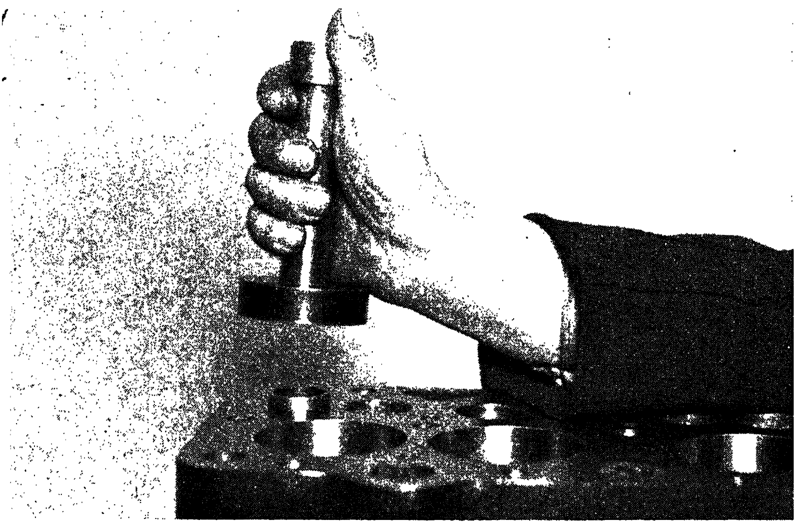


'. 2.—A METHOD OF DEALING WITH BURNT VALVE SEATINGS IS TO FIT CAST-IRON IN

Cylinder Blocks

The cylinder block of Standard engines is made of an alloy . Chromidium, which briefly means the introduction of nickel chrome other metals to the iron, which makes it much harder and more dur and offers greater resistance to wear. The idea behind this is to redu far as possible wear that takes place in the cylinders.

In the cylinders of the 1939 12-h.p. engines will be found a small sl descending downwards from the top about 2 inches. This is made hard form of iron and is shrunk into position. This sleeve is even r durable than the material of the cylinder block, and consequently, a maximum wear in any cylinder is always at the top, the presence of sleeve reduces this rate of wear considerably. Should an occasion when it is necessary to rebore the cylinders the presence of the s sleeve need not necessitate any departure from the ordinary routin this operation.

When to Rebore

Cylinders on Standard engines should be rebored when the wear in cylinder is ·006 in. or greater. In this connection the Standard M Co. Ltd. supply oversize pistons in oversizes of ·005 in., ·010 in., ·01 ·020 in., and ·030 in. Under no circumstances should the cylinder bored out at sizes greater than ·030 in. If it is necessary to bore out greater extent than this for the purpose of cleaning up any cylinder, the procedure that should be adopted is that of fitting sleeves in

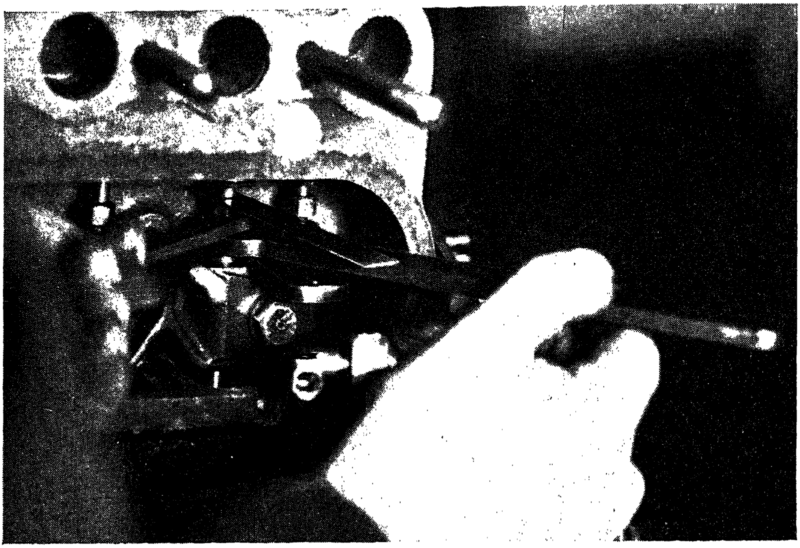


Fig. 3.—METHOD OF ADJUSTING TAPPETS
Showing the use of a taper wedge to prevent rotation.

cylinder block. Sleeves of suitable dimensions may be obtained for this purpose.

Replacing Valve Guides

Inserted in the cylinder block are the valve guides which support the valves, and these guides are made of a special iron to enable them to withstand high temperatures with the minimum amount of wear. The guides, however, will after a large mileage show signs of wear and they can be replaced with new ones. A certain amount of care, however, is necessary in installing new valve guides, for prior to forcing the old guide out of position a measurement should be taken from the top of the guide to the top face of the cylinder block, and after ejecting the original guide the new one should be driven into position with a suitable type of pin drift until it takes up the same position as the original. This may be verified by measurement from the top of the guide to the top of the cylinder block. If the valve guide is driven down into the block too far there is a possibility that the bottom end of the guide may foul the valve collar when the valve is opening and cause the camshaft to become bent or, alternatively, if the guide is not driven down far enough the top end of the guide may foul the neck of the valve and prevent it from closing properly. This, of course, would cause the valve and valve seat to burn.

Burning of Valve Seats—Causes and Remedies

The burning of valve seats is usually caused by the valve sticking in the valve guide or being prevented from closing by incorrect tappet

adjustment. This, of course, applies to engines which are comparativ new, but in engines which have covered an appreciable mileage the val have been known to burn through the action of weak mixture, and t occurs almost immediately after the operation of decarbonising a grinding-in the valves has been completed. Where cases of this ki arise an examination of the engine should be made for air leakage in t induction manifold, carburettor, butterfly and spindle, air leaks the exhaust manifold and exhaust pipe extending from the engi to the silencer. Attention should also be directed to the valve ste and the valve guides, for if wear is present at either of these points will cause weak mixture through the induction of additional air in the combustion chamber. The carburettor should also be examin and checked with a setting which is recommended by the manufactur of the car.

Where the valve itself is burnt it can, of course, be replaced with new valve, but if the valve seat is extensively burnt it is not always pc sible to clean it up and prove a satisfactory job. The usual process cleaning up a badly burnt seating with the 45° cutter results in produci a very broad valve seating in a pocket, and this has a tendency to promo further burning and other troubles with the combustion. A better way dealing with this problem is that when the seat is burnt badly it shou be cleaned up first with a 15° cutter and then the seat recut with a 4 cutter. This will provide a valve seat of narrow dimensions and w eliminate to a certain extent much of the effects of pocketing.

Fitting New Valve Seat Inserts

A further method of dealing with burnt valve seatings is to fit cast-irc inserts. A special tool, however, is necessary for machining the cylind block to take these inserts, but if this tool is not available the Standa Motor Co. Ltd.'s Service Department will be pleased to supply and fit th necessary inserts.

Tappets

The tappets which are used in Standard engines are made of cast iro the bases of which are chilled to make them dead hard. These tappe are offset from the cams, which causes them to rotate and reduce the pre sure and wear between the faces of the cams and the bases of the tappet At the top of the tappet there is situated an adjusting screw which is mad of 3-per-cent. nickel steel and is casehardened. This screw is retained i position by the action of a locknut. The clearance that should exis between the valves and the tappets is ·015 in. on all models from 193 onwards; prior to that year tappet clearances on Standard cars were fro ·004 in. to ·006 in. Where the ·015-in. clearance operates this informatio is clearly indicated on the valve-tappet cover.

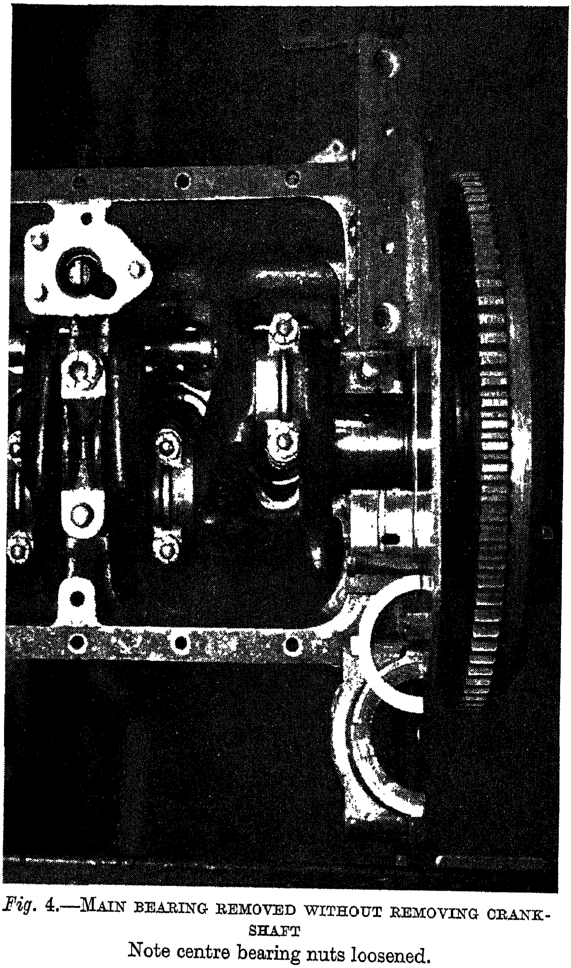


Fig. 4.—MAIN BEARING REMOVED WITHOUT REMOVING CRANK-SHAFT

Note centre bearing nuts loosened.

Noise from the tappets is sometimes caused by excessive clearance between the valve and the tappet, and this may be brought about by the hammer action of the valve on the head of the tappet screw causing a pit to form, thereby increasing the clearance. To correct this, new adjusting screws should be obtained or, alternatively, the heads of the original screws may be ground flat and then re-casehardened prior to being replaced in position. Sometimes the mistake is made of grinding the heads of the original screws but omitting the casehardening, and the result is that the noise very quickly occurs again owing to the heads of the screws being soft, and pitting begins to occur almost immediately after the screws have been inserted.

Crankshaft and Crankshaft Bearings

The crankshafts on all models are made of one of the molybdenum steels which has a very high tensile strength. On the four-cylinder engines the crankshafts are supported by three main bearings, and on the six-cylinder models there are six main bearings. Each of these bearings is in halves and each half consists of a steel shell lined with white etal. These are known as high-precision type bearings, and are the manufacturers dead to size. No fitting is therefore re-

quired, and even replacements necessitate only the removal of the old bearings and the insertion of the new ones. This also applies to the big-end bearings, and provided there is no undue wear on the crankshaft journals new big-end and main bearings may be inserted without completely dismantling the engine, or without removing the engine from the chassis.

Should wear eventually occur on the crankshaft to an extent which would warrant the crankshaft journals being reground, it is important to remember that provided the crankshaft is reground to the correct undersizes, bearings of suitable dimensions may be obtained from the makers. These bearings are supplied in undersizes of ·020 in. and ·030 in. The crankshaft may therefore be reground on two occasions before it becomes necessary for it to be replaced with a new one.

Connecting Rods

The connecting rods in the four-cylinder engines are made of steel, with a high-precision bearing at the big end and a bronze bush at the small end. As previously mentioned, the big-end precision bearings require no fitting, and if wear develops the bearings should be removed and replaced with new ones. Under no circumstances is it advisable to file the connecting rod or cap to let the bearing together, as so doing only produces an unsatisfactory bearing necessitating its renewal in the near future. If the connecting rod has been filed it will also be necessary to fit a new connecting rod when future repairs are carried out. The small-end bush is machined to fit the gudgeon pin supplied with the piston, and the fit of the gudgeon pin when cold is a push-in fit with the fingers. On the six-cylinder models the connecting rod is made of duralumin, and the same remarks apply in connection with this so far as filing the connecting rod and cap is concerned. The only difference consists in the fit of the gudgeon pin, which in the duralumin rod is a tight fit when cold. The degree of tightness should be gauged to obtain a floating gudgeon pin when the connecting rod is operating at normal engine temperatures.

Pistons

The piston which is fitted in Standard engines is known as the "Aerolite," and is elliptical. An examination will reveal that the measurement across the thrust face of the piston is about ·005 in. larger than the measurement across the gudgeon-pin sides. It will also be observed that the main heat flow from the piston top is down through the gudgeon-pin sides, which are in direct contact with the crown, whereas the thrust faces are isolated to a certain extent by means of slots and flutes; the maximum expansion therefore occurs on the gudgeon-pin sides, and it is contended that under heat this piston expands round and conforms truly to the contour of any given cylinder. There are, however, no special points to observe in assembling these pistons other than the fact that each

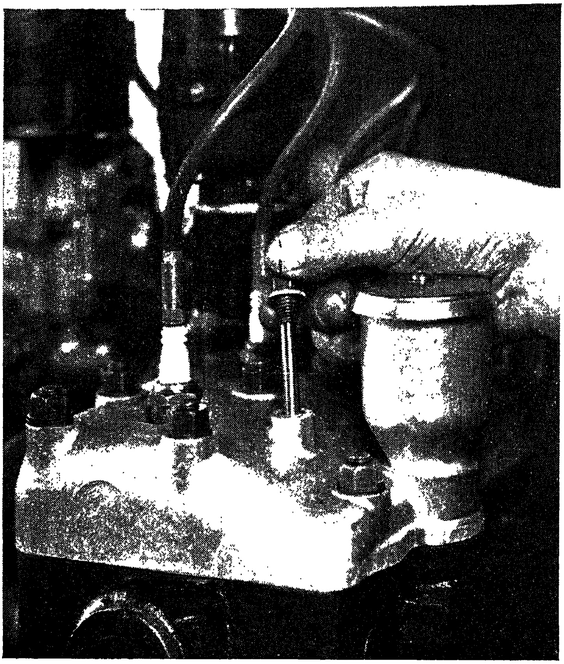


Fig. 5.—Valve timing
Showing timing plug over rear piston.

gudgeon pin has been carefully fitted to the piston and it is advisable to take precautions to prevent the gudgeon pins being inserted in any other pistons.

These pistons have two pressure rings and one oil-control ring, and in the event of having to fit new piston rings the pressure-ring gaps should be ·0015 in. to ·002 in., and ·003 in. to ·006 in. on the oil-control rings.

Camshaft Bearings

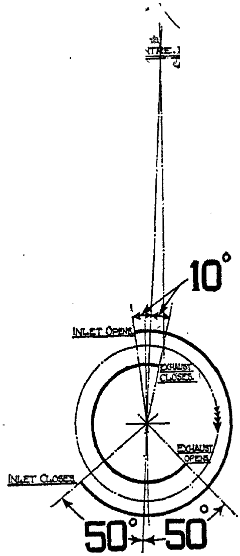
The bearings that support the camshaft on the 12-h.p., 14-h.p., and 20-h.p. engines are steel shells lined with white metal, and they are retained in position by the end of a setscrew which passes horizontally through the near side of the cylinder block and engages with a hole in the bearing. The point of importance is that the bearings have been machined in position, and in the event of entirely dismantling the cylinder block care should be taken to ensure that these bearings are replaced in their original position. In point of fact, there is really no necessity for their removal, as experience shows that very little wear occurs on these bearings, and they more or less last the lifetime of the car.

It is possible, however, owing to the failure of the owner of the car to adequately maintain lubrication of the engine, for these bearings to become damaged, in which case new camshaft bearings may be obtained for insertion in the cylinder block.

The bearings, however, are supplied slightly undersize and would therefore require fitting to suit the journals of the camshaft. Under the head of each of the setscrews that retain these bearings in position will be found a plain distance washer, and it is necessary that these washers be not removed from the setscrew, which will otherwise be too long and will therefore foul the camshaft journal.

Valve Timing

When a complete overhaul of the engine becomes necessary it is entirely dismantled for the necessary work to be carried out, and on completion of this work it is essential that the valve timing should be reset in accordance with the manufacturers' formula. This arrangement is illustrated by the diagram (*see* Fig. 6). On the diagram it will be observed that the exhaust valve closes 10° after top dead centre, and therefore when resetting the timing the crankshaft should be rotated until the pistons Nos. 1 and 4 are top dead centre (in the four-cylinder engine) and Nos. 1 and 6 are top dead centre (in the six-cylinder engine), then continue the rotation until the pistons are $\frac{3}{64}$ in. after top dead centre. The camshaft should be turned in the order of engine rotation until the exhaust valve of No. 1 cylinder opens and then just closes, when the crankshaft and camshaft should be connected together by the timing chain.



6.—VALVE-TIMING DIAGRAM

As the tappet clearance recommended is ·015 in. the tappets should therefore be adjusted prior to the operation of resetting the valve timing, and on checking the actual closing position of the exhaust valve the use of a ·014 in. feeler gauge should be employed between the exhaust valve and the tappet, and the moment the feeler gauge can easily be extracted is the clear indication of the instant of the valve closing. After the timing chain has been reassembled in position it is advisable again to check the valve timing, as there are possibilities of slight variation in the timing owing to movement of the camshaft.

The camshaft sprocket is retained on the end of the camshaft through the medium of two setscrews or two studs, according to the models concerned, but there are actually four holes provided, although only two are in use at one time. The other two holes will provide a half-tooth variation, so that the valve timing can be altered within the limits provided by the additional holes in the camshaft sprocket.

Valve-timing Cover

At the front of the engine there is the cover which encloses the camshaft sprocket and timing chain, and there is an aperture in the

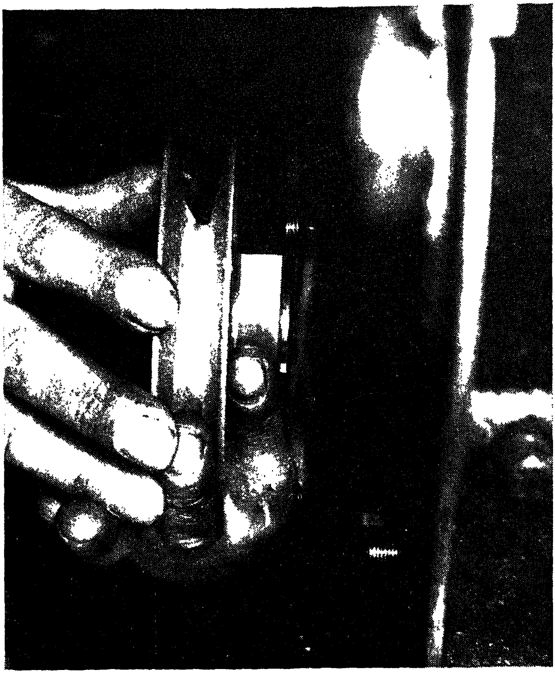


Fig. 7.—FITTING FAN PULLEY ON CRANKSHAFT BY AID OF PINCH BOLT PROVIDED

Space should be left between pulley and timing case, using a feeler gauge to obtain correct distance.

cover through which the crankshaft extends and to which a dog nut is attached for the purpose of starting the engine with the starting handle. Also on the end of the crankshaft there is a pulley which carries the fan belt, and this pulley has an extension which passes through the aperture in the timing cover. On the outside of the pulley extension or boss there is cut an oil-return thread which is in the reverse rotation to that of the crankshaft and, owing to the very fine clearance between the boss of this pulley and the aperture in the timing cover, oil is prevented from leaking out at that particular point. Oil may, however, leak out if the clearance between the boss of the pulley is greater than ·006 in., or if there is actually metallic contact between the timing cover and the boss of the pulley. Metallic contact between these two parts also produces a drumming noise, particularly noticeable at slow engine speed, and both these complaints may be corrected by centralising the aperture of the timing cover with the boss or extension of the fan pulley. Should there, however, be extensive clearance between the boss of the pulley and the aperture in the cover a new timing cover should be obtained.

Fan, or Impellor

The pulley at the front of the crankshaft drives a fan through the medium of a belt. On the 8-h.p., 9-h.p., and 10-h.p. models the fan is attached to the dynamo, which is also driven through the same medium. On the 12-h.p., 14-h.p., and 20-h.p. models the fan is attached to an impellor or water pump in the water-cooling system, which is also driven

by the belt. The main body of the impellor is an iron casting, with an extension which carries a pulley supporting the fan blades, and to maintain the smoothness for which these engines are renowned it is very important that the fan assembly should be in a state of balance.

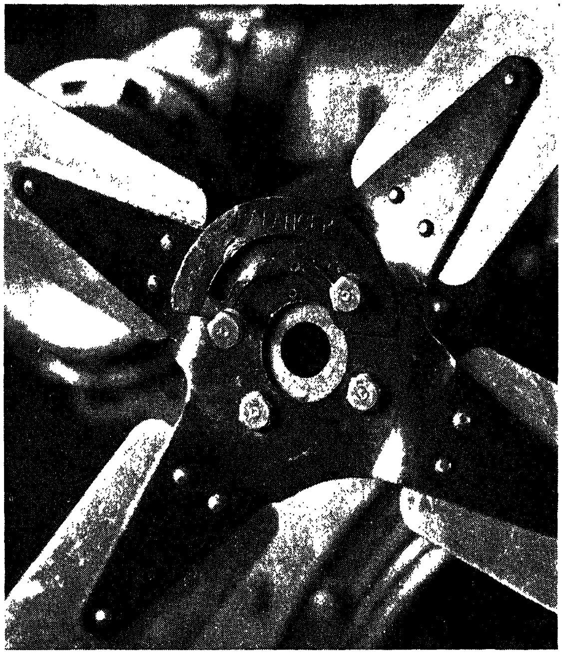


Fig. 8.—REFITTING BALANCE WEIGHT ON FAN ASSEMBLY

Ensuring Balance of Fan Assembly

The manufacturer prior to adding the fan to the impellor assembly has the fan balanced, and to assist in this respect a small balance weight, consisting of a circular piece of steel through which is placed an elongated slot, is bolted in position. The balance weight is moved until it is found that in a certain position the fan is in a state of balance, and the weight is therefore secured in that position by two of the setscrews that hold the fan blade to the fan assembly. A small hole is drilled through the balance weight, through the fan blades, and into the body of the fan pulley, so that in the event of this unit being entirely dismantled it will be unnecessary to go to the trouble of rebalancing the fan, as all that is required is to assemble the parts with the three holes in alignment. Failure to ensure that the fan is balanced is likely to cause roughness in the engine and perhaps failure of the races that support the fan assembly.

Oil Pump

The oil pump is mounted on the underneath side of the crankcase and is submerged in the oil which is in the sump. It is driven by a vertical shaft which ascends to the top of the engine and also drives the ignition distributor. This shaft is in turn driven by a gear from the engine camshaft, and in the process a certain amount of upward thrust takes place. The distributor is mounted on a bracket on top of the cylinder head, and

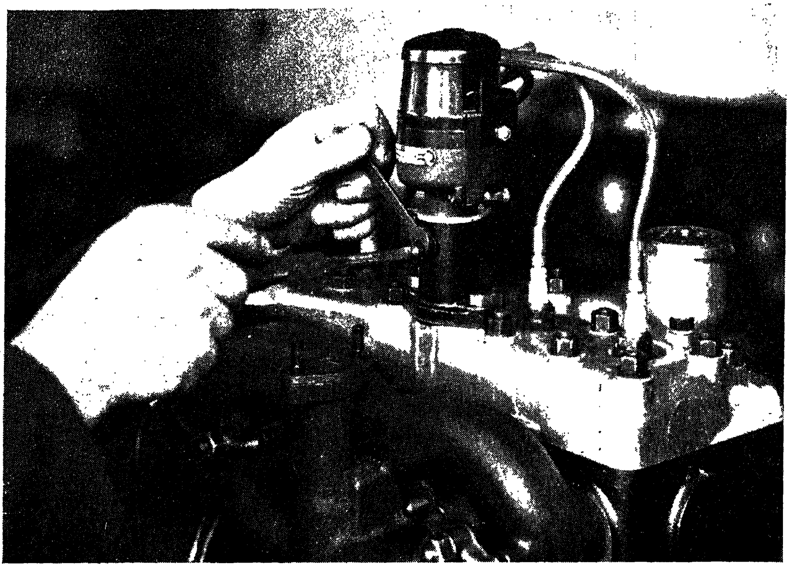


Fig. 9.—THE OIL PUMP

Showing resetting location setscrew for oil pump and distributor driving spindle.

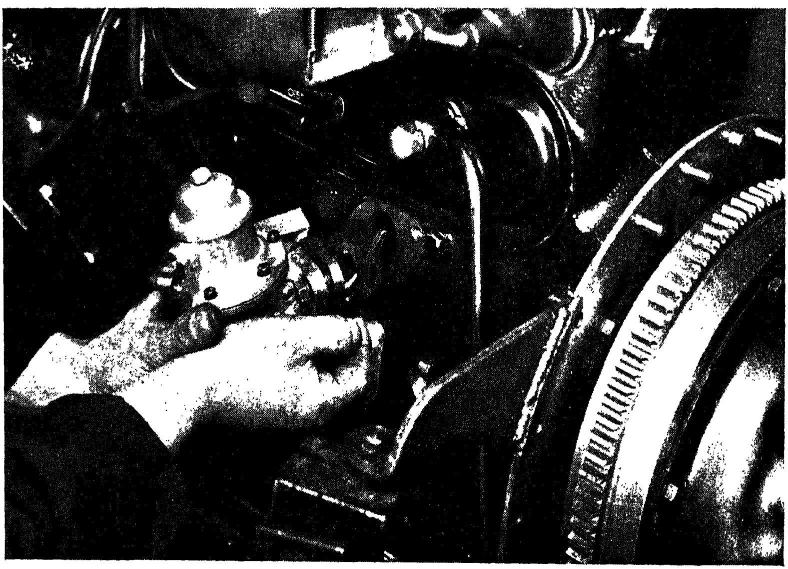


Fig. 10.—THE PETROL PUMP

Fitting packing washer to petrol pump to reduce pressure.

there is a setscrew which passes through this bracket and engages with an annular groove in the body of the distributor. The presence of this screw prevents any upward lift of the distributor, but it has been known for owners who have decarbonised their own engines to have omitted to replace this screw, and the result has been that, owing to the upward thrust of the spindle, the distributor has been lifted sufficiently for the lower end of the driving spindle to lose contact with the oil pump. The importance of the screw in the bracket that supports the distributor will therefore be appreciated.

It is also important that this bracket should be central with the shaft that drives the distributor, and if for any reason this bracket has been removed from the cylinder head it is necessary before retightening the nuts which secure it in position to centralise the bracket with the driving shaft.

Petrol Pump

A mechanical type of petrol pump driven from off the engine camshaft is fitted to all Standard engines. Generally speaking, no adjustment to this unit is necessary, the only exception being where a complaint of excessive petrol consumption arises and it is discovered that the petrol pump pressure is above that which is called for on the specification. This pressure should be between 2 and $2\frac{1}{2}$ lb., recorded at engine-idling speeds. Occasionally the petrol pump may give off a greater pressure than that which has been previously referred to, and as a result may force petrol into the carburettor float chamber against the resistance of the needle valve, and under such circumstances it will be advisable to reduce the pressure. This may be achieved by packing the petrol-pump body out from the engine crankcase, and packing washers of a certain thickness may be obtained for this purpose. Conversely, if it is necessary to increase the pressure this may be carried out by reducing the thickness of the packing washer between the pump body and the flange on the crankcase.

Ignition Timing

The ignition timing on all Standard engines should be set in accordance with the old formula of "fully retarded top dead centre." As the advance of the ignition is automatically obtained as the speed of the engine increases, the fully retarded position is obtained when the engine is stationary. To set the timing, therefore, the crankshaft should be rotated until the piston in No. 1 cylinder is top dead centre with both valves closed. No. 1 cylinder on Standard engines is the one nearest to the flywheel. The distributor should now be set with the rotor pointing to the segment in the distributor cover from which the high-tension lead continues to No. 1 cylinder. The contact-breaker points should at this stage be on the point of opening, and the distributor should finally be secured in position. The order of firing is 1-3-4-2 (four-cylinder) and 1-5-3-6-2-4 (six-cylinder), and the high-tension leads from the distributor cover should be affixed to

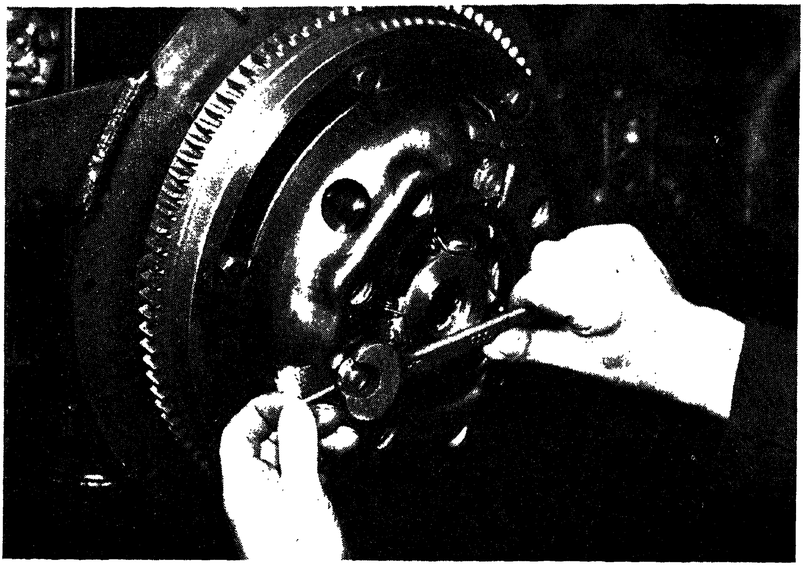


Fig. 11.—ADJUSTING THE CLUTCH TOGGLES
Showing drilled nut for locking purposes.

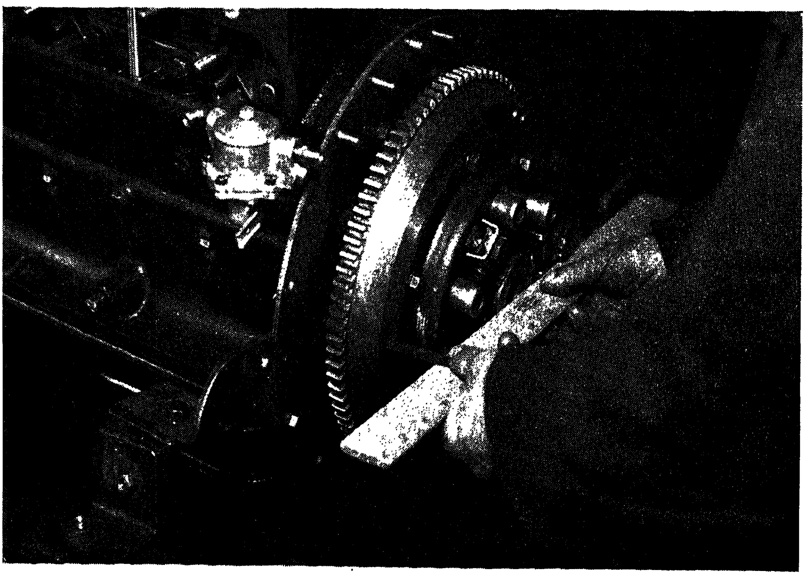


Fig. 12.—CHECKING PARALLELISM OF RELEASE LEVER PLATE AND FLYWHEEL FACE
The measurement should be as follows: $6\frac{1}{4}$-in. clutch, $1\frac{5}{8}$ in.; $7\frac{1}{4}$-in. and 8-in. clutch, $2\frac{3}{16}$ in.; 9-in. clutch, $2\frac{5}{16}$ in., from outer face of lever plate to faces of toggle arms.

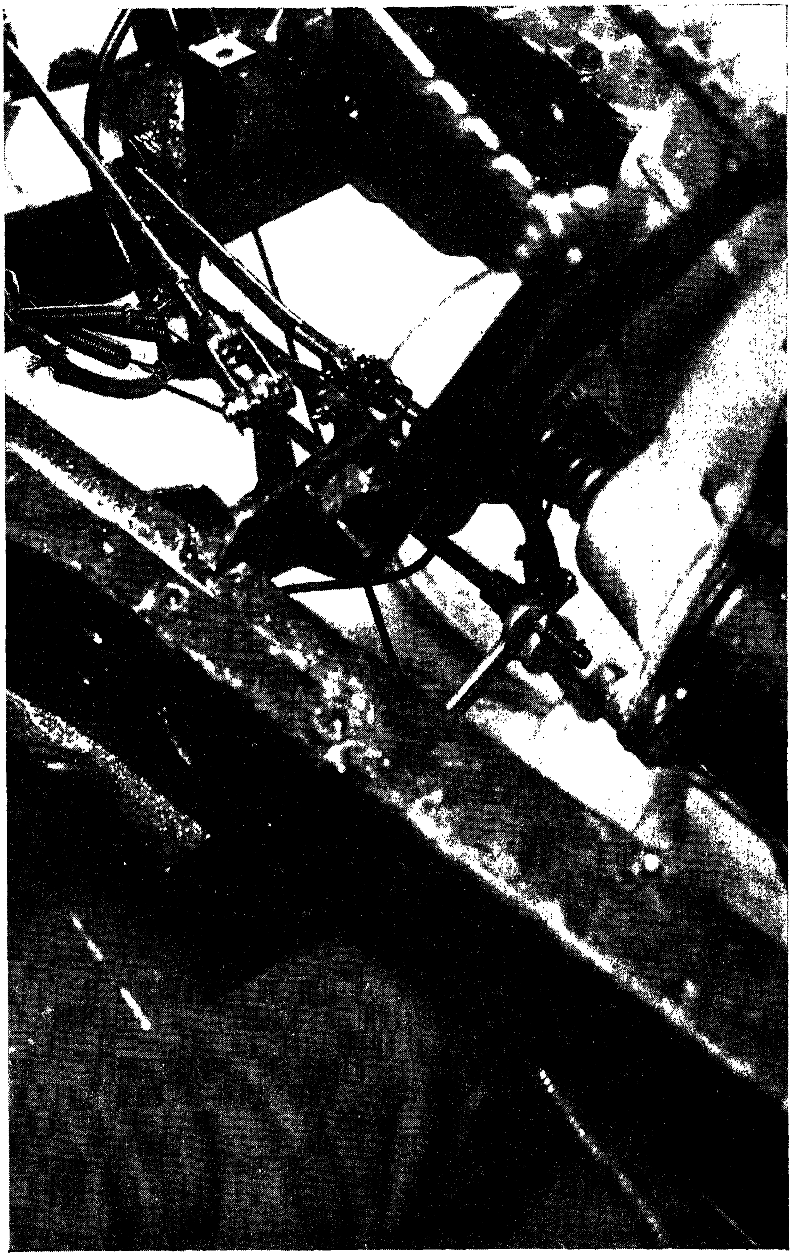


Fig. 13.—Restoring clearance in release mechanism on clutch

the sparking-plug terminals in the correct cylinders in accordance with the rotation of the distributor. Prior to setting the distributor timing it is advisable to check the rotation, as in some engines the distributor may have clockwise rotation, whilst in others it may be anti-clockwise. It is important, therefore, to ascertain this point before connecting the high-tension leads to the sparking plugs.

Carburettor

The "Solex" carburettor is employed by the Standard Motor Co. Ltd. on all the engines which are now being manufactured. Careful tests of these engines are made by road and bench test to ascertain the best carburettor-jet setting suitable for each engine according to the respective models, and provided these jet settings are unaltered there is very little adjustment required in respect of the carburettor other than occasionally cleaning the filter, the needle-valve seating, the float chamber, and checking the tightness of the various pipe unions to ensure that there is no leakage. There is, of course, the adjustment of the slow running, and provided the controls to the carburettor are adjusted correctly the correction of the slow running should be comparatively simple, as it only requires the rotation of an adjusting screw which varies either the quantity or the richness of the mixture. It has to be remembered, however, that to get the best slow running or to get the best results from any engine it has to be in what may be referred to as "good tune." Many complaints have been made with regard to carburation which have eventually been found to be caused by some mechanical defect in the engine itself. (*See* also the article on "Solex" carburettors, in Vol. I.)

Model	*Type of "Solex" Carb.*	*Choke*	*Main Jet*	*Correction Jet*	*Pilot Jet*	*Air Bleed to Pilot*	*Needle Valve*	*Starter Setting*
8A	26AIC	21	95	220	45	1·5	1·5	GA4 GS95
10C	30FAI	22	105	220	45	1·5	1·5	GA4 GS100
12C	30FAI	24	120	210	45	1·5	1·5	GA4·5 GS105
9C	30AIP	25	105	2·40	45	1·5	2·0	GA4·0 GS100
10BL	30AIP	25	105	2·40	45	1·5	2·0	GA4·0 GS100
12CB	30AIP	27	120	2·70	45	1·5	2·0	GA4·5 GS1·05
14C	35AIP	29	125	2·30	50	1·5	2·0	GA5·0 GS1·55
20A	351FL	30	135	2·40	50	1·5	2·5	GA5·0 GS1·95

CLUTCH

The clutch is a single floating plate unit, and consists of a flywheel which has a ground surface, a clutch floating plate, and the clutch pressure plate which is housed in a steel cover. In this cover there are also six coil thrust springs, which vary in their pressure according to the models concerned. There are also three release levers, and on the end of the levers there is a release lever plate retained in position by spring clips.

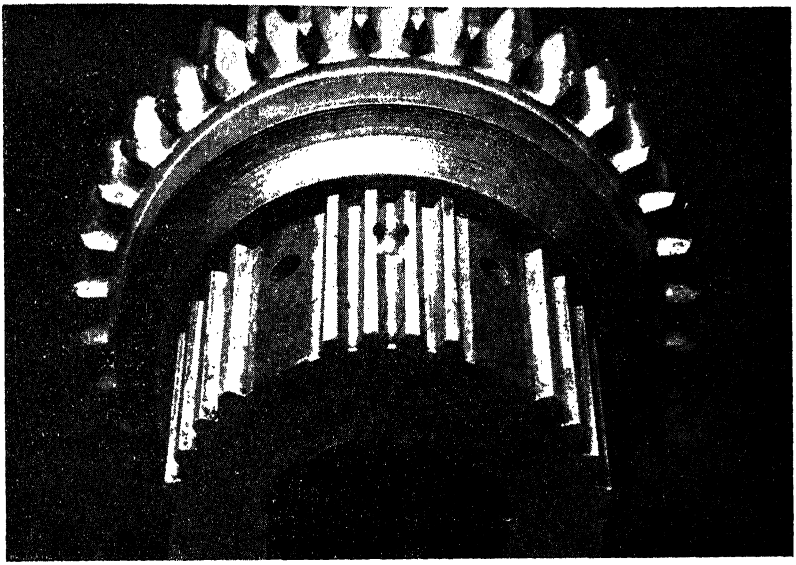


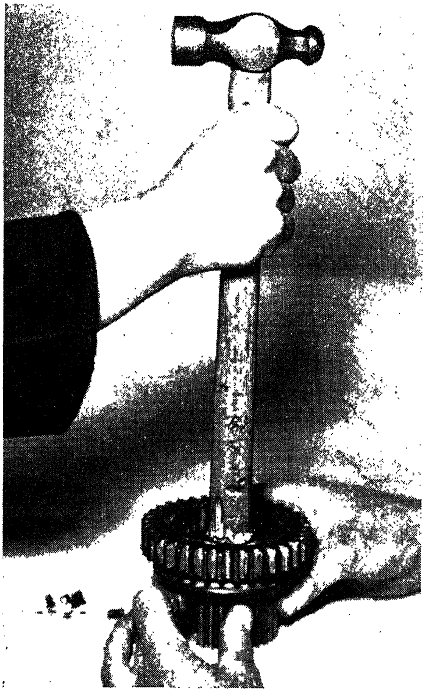
Fig. 14.—THE SYNCHROMESH GEARBOX

Showing meshing of plunger and ball on second and first mainshaft gear with splined sleeve.

The steel housing containing the pressure plate is bolted to the flywheel, and the centre plate is gripped firmly between the pressure plate and the flywheel when the clutch is engaged. Disengagement is obtained by operating the clutch pedal, which causes a carbon block known as the release bearing to operate the three levers by pressure on the lever plate. This action of the three levers causes the pressure plate to be drawn farther into the steel housing, thereby releasing the grip on the centre plate, allowing it to come to rest. Although no adjustment is provided on this clutch assembly with the exception of adjustment for the clutch pedal, there are, nevertheless, one or two points of importance that should be known to those who may be called upon to dismantle these units.

Important Points in Dismantling Clutch

Firstly, it is essential that the ground faces of the flywheel, the pressure plate, and the release lever plate should all be parallel with each other within very fine limits. When a flywheel is bolted to the end of the crankshaft in the assembly plant it is checked by means of a dial gauge, and the contact of the gauge is on the ground face of the flywheel, which is then rotated, and if according to the gauge the flywheel is running out of truth ·003 in. it is removed and examined for burrs or foreign matter between the faces of the flywheel and the crankshaft.



15.—METHOD OF FITTING BALLS SPRINGS IN SYNCHRO SLEEVE

Secondly, should the circumstances warrant the complete dismantling of the clutch pressure plate assembly, it is necessary to mark the lever bolts and nuts to ensure that they go back to their original positions, and, furthermore, a check should be made to ensure that when completely dismantled the face of the pressure plate is parallel with the face of the release-lever plate.

Thirdly, the clearance which should exist between the carbon release bearing and the release-lever plate is $\frac{1}{16}$ in. when the clutch pedal is back against the toe-board. It is also advisable to warn the driver of the car not to drive with his foot on the clutch pedal in such a way that it would cause continual contact between the carbon thrust bearing and the lever plate, as this would set up excessive wear on the carbon thrust. (See also the article on the Borg & Beck clutch in Vol. I.)

GEARBOX

A synchromesh type of gearbox with synchronising device on second, third, and top gears has been in use on Standard cars with satisfactory results for a number of years.

Operation of Synchronising Device

The synchronising device consists of a sleeve which is splined on the gearbox mainshaft and a gear splined on the sleeve. These two parts are, however, kept in contact with each other by the medium of six spring-loaded balls equally spaced around the circumference of the sleeve. Each end of the sleeve is machined out to form a taper cup, and to engage gear the operation of the change-speed lever slides the sleeve along the mainshaft, and as the gear has an extension or cone the sleeve when it contacts with the extension of the gear produces the action similar to a cone clutch. The pressure created on the faces of this miniature clutch is in accordance with the pressure required in overcoming the resistance of the spring-loaded

balls to obtain forward motion of the gear along the sleeve. Provided the clutch has been disengaged, this action of the miniature cone clutch in the gearbox causes the gear which is about to be engaged to slow down until it is rotating at a speed in accordance with that of the car, and the further progression of the gear along the sleeve results in the two gears engaging whilst revolving at the same speed. This action is similar on second, third, and top gears. The parts which engage each other and permit the synchronisation of the gears are made of hardened steel, which increases the life of the synchronisation, as wear over a long period of miles is very minute.

Causes of Loss of Synchronisation

Loss of synchronisation, however, may be caused by loss of spring tension on the coil springs which hold the sleeve and the gear together. For top- and third-speed engagement the resistance set up by the spring-loaded balls is equal to a pressure of 42 lb. On the second-speed sleeve it is equal to a pressure of 50 lb. Should, therefore, the gearbox have to be dismantled owing to loss of synchronisation it would be advisable to replace the coil springs in the synchronising sleeves, as there is a possibility that they may have lost their tension.

In changing speed there should be a very slight pause between gears to give the necessary time for slowing down.

Oil Leakage

At the front and rear of the gearbox there is housed in the end covers an oil-retaining device known as a super oil seal. In the event of oil leakage from the gearbox at either the front or rear it will perhaps be necessary to replace the super oil seal, but prior to doing so the oil level in the gearbox should be checked, as it is quite possible that the oil leakage is due to an excessive quantity of oil in the box.

The oils recommended for use in this unit are Essolube 30, Wakefield Patent Castrol XL, Vacuum Mobiloil A, and Double Shell. The use of a thick grade of oil will adversely affect the operation of the synchronising sleeves and may be responsible for damage to the gears caused by crash engagement.

OVERHAUL OF 10-H.P. AUSTIN GEARBOX AND CLUTCH

By W. T. MEAD

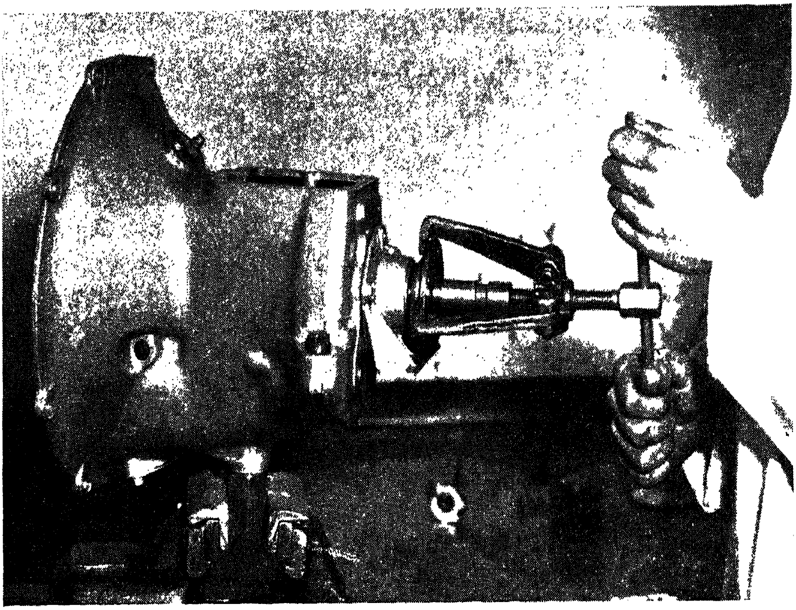


Fig. 1.—Stripping gearbox
Removing rear gearbox driving plate with drawer.

BEFORE beginning any repairs to the gearbox or clutch it is advisable for it to be tested by a tester or mechanic with a sound knowledge of the construction of the gearbox. The cause of the defects and the actual replacement parts necessary can often be decided upon more easily from this test than from an examination of the parts; this applies more to the gearbox.

A point to watch before any dismantling is started is the grade of lubricants in the box—only the grade recommended by the makers should be used; a thicker oil not only interferes with the synchro action but is liable to cause seizure of the bronze sleeve or intermediate gear bushes and possible stripping of the gears. In the case of slow synchro action, care must be taken to ascertain whether the defect is caused by the syn-

chronisers and cones or by a spinning clutch. Oil getting on to the clutch plate can cause the clutch to spin and stop the cones holding. It is best to look to the clutch plate before dismantling the box.

Having decided that the box should be removed, the procedure for that operation and the removal of the clutch is as follows:

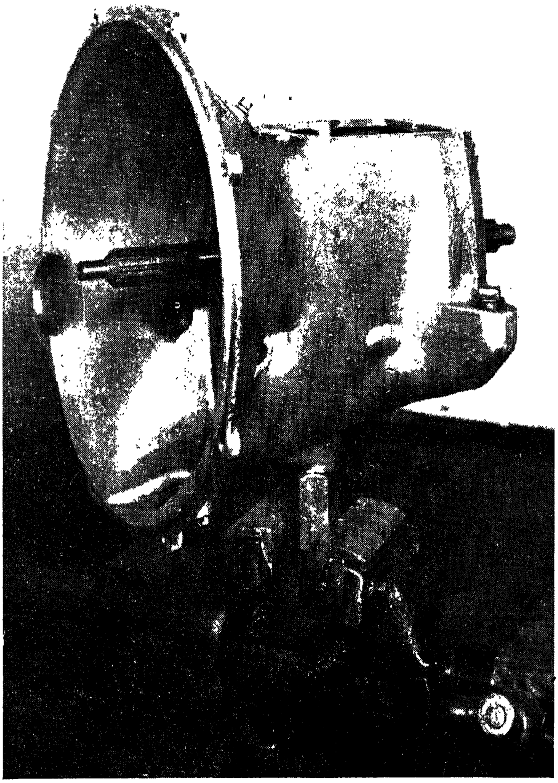


Fig. 2.—STRIPPING GEARBOX
Showing plug for mounting gearbox in vice.

Removal of Gearbox

Commence by removal of front-seat cushions, floor carpets, and the fume and draught excluder from around the hand-brake and gear levers. The latter is held by eleven slot-headed securing screws. Unscrew the knob from the gear lever and pull the handbrake lever hard on; the rubber cover will then lift off; the small metal extension to the transmission tunnel will also come away. Still from inside the car, disconnect the speedometer cable and remove the four upper gearbox-to-engine securing bolts; next remove the bolts holding the front Hardy-Spicer joint to the third motion shaft flange. Undo the clutch-pedal clamping bolt and drive the pedal off the shaft; now support the weight of the engine at the rear end, under the clutch housing, on a jack. By using a jack the weight will be taken off the rear rubber suspension, which can be removed from the chassis frame. Unscrew the remaining engine-to-gearbox bolts. Before removing the gearbox put the lever into first or third gear and let the hand-brake lever right off. The gearbox can now be pulled clear of the engine and lowered to the floor. If the gearbox

housing fouls the metal floor, it can be cleared by lowering the jack a slight amount.

Previous Type

On the models which left the manufacturers between May 1935 and August 1936 a slightly different procedure for removal is necessary. Carry out the work as already described up to the time of removal of the gearbox, then pull back the box sufficiently to get at the setscrews holding the flywheel cover to the flywheel. Knock up the locking washers and remove the setscrews by unscrewing each a little at a time and working round the flywheel.

When they are all out, the gearbox with the flywheel coverplate and clutch assembly can be removed together. When reassembling, the clutch should be assembled and fitted to the flywheel, the toggles given their right setting, and it should then be removed, placed on the first motion-shaft spline and reassembled with the gearbox, in the same manner as it was taken down.

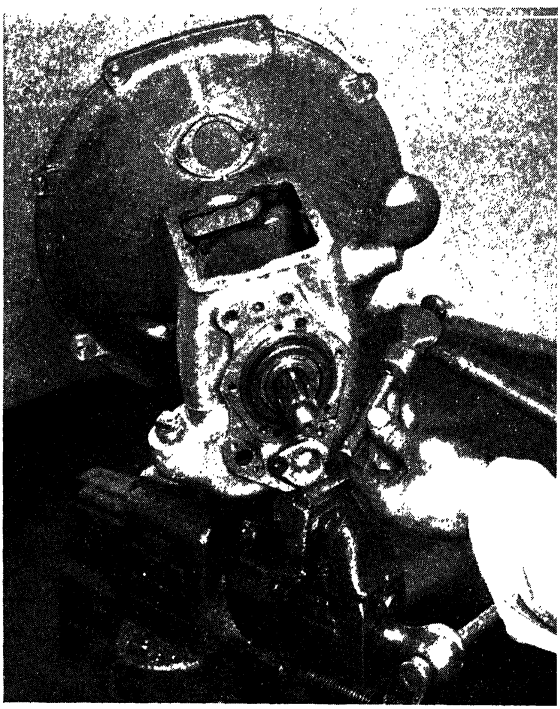


Fig. 3.—STRIPPING GEARBOX
Tapping out layshaft-spindle.

Stripping the Box

For easy handling it is advisable to make a plug with a long head, either square or hexagonal in shape, to screw into the bottom of the box in place of the ordinary drain plug; this can be held in the vice (Fig. 2). With the box held thus, first remove the lid, and then prise off the change-speed gate and interlocking device from its recesses in the top of the box. Now remove the third motion-shaft flange, and to

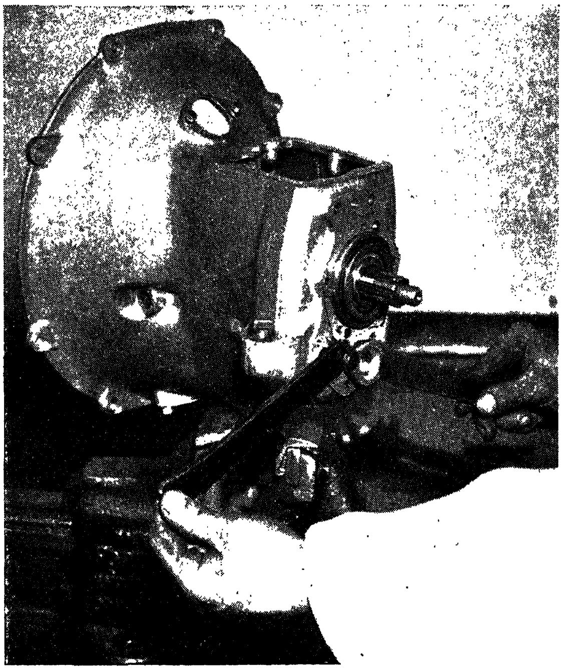


Fig. 4.—STRIPPING GEARBOX
Levering out layshaft-spindle.

prevent them turning whilst unscrewing the nut, slip both top and second speeds into gear. Draw the flange off with a proper drawer; do not knock it off (Fig. 1). Next remove the nuts from the ends of the selector rods. These are at the end of the box, just above the rear cover.

The first- and second-speed rod is located by a locking plate. This rod will tap out toward the front (take care of the little shims which fit between the shoulder on the rod and the inside of the gearbox). The other two rods will screw out. Take care of the balls and springs when drawing the rods from the forks; the forks will now lift out. Now remove the clutch-withdrawal mechanism, draw out the clutch shaft, and take off the gearbox front cover.

It is next necessary to drop the lay-gears down out of mesh with the main gears, before the first- or third-motion shaft can be removed. This means the layshaft spindle must be withdrawn. First take off the rear gearbox cover and remove the speedometer pinion; now take out the two setscrews which secure the flange of the spindle, tap the flange round until one end projects beyond the box (Fig. 3) enough to be able to drive it sufficiently forward to get a pair of small levers (tyre levers are suitable) between it and the box. It can then be levered out without damage to the flange or box (Fig. 4).

The lay-gears should be lowered gently to the bottom of the box and covered with a pad of cloth to prevent the other gears coming in contact with them during the remainder of the operation. Now with a hide mallet, drive the third motion shaft forward until the ball-race on the first motion shaft is clear of the box; the shaft complete with ball and



Fig. 5.—STRIPPING GEARBOX

Removing third motion shaft complete, showing amount of clearance in case for shaft.

needle-roller race can now be taken away. Now drive the third motion shaft back in the opposite direction, so that the ball race and its housing are free from the rear of the box.

With the shaft right back the third and top synchroniser can be taken off the shaft and out through the top of the box. Draw the ball race and housing from the shaft, engage the second gear to allow more clearance, and the shaft can then be lifted out through the top of the box (Fig. 5); the layshaft gears can follow, and there only remain the reverse gear and spindle to come away.

Remove the two setscrews which hold the flange of the spindle and drive the spindle out from inside the box, using a small-diameter drift through the first motion shaft housing. Turning to the third motion shaft assembly, it will be seen that the second- and third-speed gears rotate on a bronze sleeve, and this is retained on the shaft by a split steel ring. Prise off this to remove it. The bronze sleeve will then pull off the shaft. The second- and third-speed wheels are then free to leave the bronze sleeve.

A special tool can be obtained from the manufacturers for removing or inserting the balls and springs into or from the synchroniser. If the tool is not used, wrap the units in a cloth before pulling off the synchronisers, otherwise the balls and springs will fly out and probably be lost.

Overhaul of the Box

Defects in synchromesh boxes can be divided into three classes :

(1) Noise.

(2) Failure of the synchro action.

(3) Slipping out of gear.

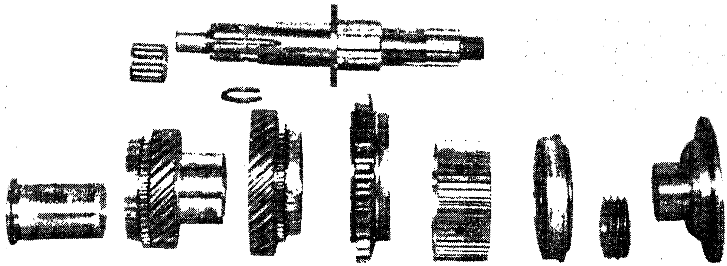


Fig. 6.—THE UNITS OF THE THIRD MOTION SHAFT ASSEMBLY AND THE ORDER IN WHICH THEY ARE MOUNTED

Taking the defects in order, as enumerated above, the first—noise—can again be divided into three classes.

(*a*) Knocking
(*b*) Whining or hum.
(*c*) Roughness.

Knocking

(*a*) is usually caused by a chipped tooth or ball, or some foreign matter lodged between the teeth of one of the gears. A chipped ball in one of the races can cause a very regular knocking noise at times. Examination of the balls under a magnifying glass is advisable.

Whining or Hum

(*b*) is caused by wrongly meshing gears, possibly worn on the pitch line, although this is unlikely under a very high mileage. The most likely cause is worn races, allowing the gears to drop out of correct alignment. Examine the gear closely, again using a magnifying glass, for wear, indentation, or roughness on the pitch line. Do not change any gear unless absolutely necessary, as the changing of one gear will sometimes lead to the renewal of a complete set before a quiet-running box is obtained.

Roughness

(*c*) is nearly always caused by one or more of the races. Thoroughly wash the races out and finish off with perfectly clean petrol; feel them for roughness and examine them through a magnifying glass for pitting. If at any time a thick oil has been used it is possible for the recess of the first motion shaft to be badly lined. The thick lubricant sticks up the cage and the rollers revolve in a stationary position, with the result that grooves are worn in the recess of the first motion shaft and sometimes on the end of the third motion shaft. When the cage frees itself, usually

when the oil is changed or the gearbox washed out, the rollers passing over these grooves set up a considerable roughness. This roughness shows up when the gears are in neutral and intermediate gears, but not when top speed is in operation.

When deciding the question of the amount of wear in the ball races, consideration must be given to the grade fitted in the first place. Ball races are made in three grades of diametrical clearance, known as X, Y, and Z fits. These are indicated respectively by faint circular markings thus : 0, 00, 000 on the inner rings. Those fitted to the gearbox are grade 00. This grade allows of more thrust capacity or lateral play than those of the finer grade, and this lateral play must not be mistaken for wear.

Failure of the Synchro Action

First inspect the cones and synchronisers to make sure they grip. The cones should protrude from the synchronisers a little. If the cones are worn and need replacing, new gears will have to be fitted also ; they are not supplied separately. Make sure that the balls are free in the synchronisers. Clean off any burrs on the edges of the holes. Renew the springs if weak. Ensure that the cones and synchronisers are running true to each other. The best method of checking this is to assemble the whole of the main gears and synchronisers on the third motion shaft and run it between centres ; mark the position of the synchronisers on the spline so that they can be assembled finally in the same position. Make sure that the driving-gear teeth have not been burred up by the coupling sleeves ; under normal conditions this could not happen, but if the car has been run a good time without the synchros working, such may be the case (Fig. 6).

Inspect the bushes of the lay-gears ; if worn they should be renewed. The old ones must be pressed out, new ones pressed in, then the gear assembly set up true in the lathe and bored out to size. The same operation can be carried out on the reverse gears if necessary.

Gears Slipping Out

This is a very uncommon complaint now, although on the early types it used to happen to the first-speed gear on occasions under a heavy load. The modifying of the first-speed selector rod cured this. The early models had a groove turned on it like the third and top and reverse rods, but by milling a groove on one side it was possible to go deeper without weakening the rod. The sides of the groove were also inclined to allow of easier engagement.

The only two reasons now why gears come out are, (1) the sticking up of either the synchro or selector balls ; or, (2) excessive end float of the main gears on the third motion shaft. This can be, either because the steel locking ring is not tight against the bronze sleeve, or because the steel thrust washer has worn, allowing too much end float for the inter-

mediate gears; approximately ·002 in. end float should be allowed. If a new third and top coupler or first-speed gear is required it may be necessary to lap them on the synchronisers. Hold them in the vice between a couple of old small pistons and lap until they are free in any position (*see* Fig. 7).



Fig. 7.—TAPPING NEW FIRST-SPEED GEAR ON SYNCHRONISER

Showing the second-speed synchroniser held between two old pistons in the vice to allow easy lapping of the first-speed gear.

The makers can supply special service tools for all the operations described, and although it may not be an economical proposition to buy these for one job, it will pay well to get them if a sufficient supply of work is available; two particularly useful ones are shown in Figs. 8 and 9.

Having decided on the new parts necessary, and fitted up the main gear assembly, proceed with the reassembling.

Reassembling the Box

First refit the reverse gear and spindle, then place the lay-gears in the bottom of the box, large gear forward, again covering them with a pad of cloth; now pass the third motion shaft and gear into the box from the top, refit the third- and top-speed synchroniser to the correct spline, and tap on the ball race and housing as far as it will go. Then tap the race right home, using a piece of tube as a drift. Place the needle-roller race in position on the end of the third motion shaft; now drive the first motion shaft and race into position again, using the tubular drift.

Now take out the cloth pad and turn the gearbox upside down, letting the layshaft gears fall into mesh naturally with the main gears. Now replace the lay-gear spindle, making sure the brown-paper washer is in position; gently turn the main shaft whilst tapping home the layshaft spindle. The teeth of the gears will find their proper position then without damage. Next pass the speedometer pinion on to the third

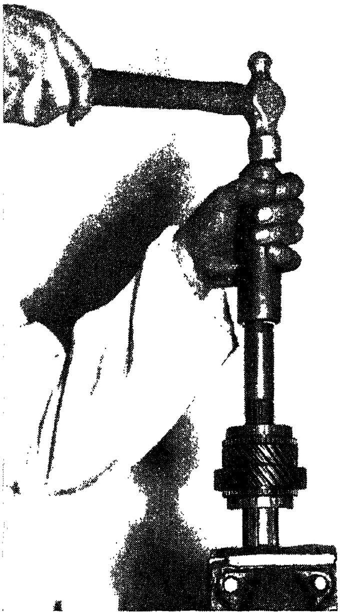
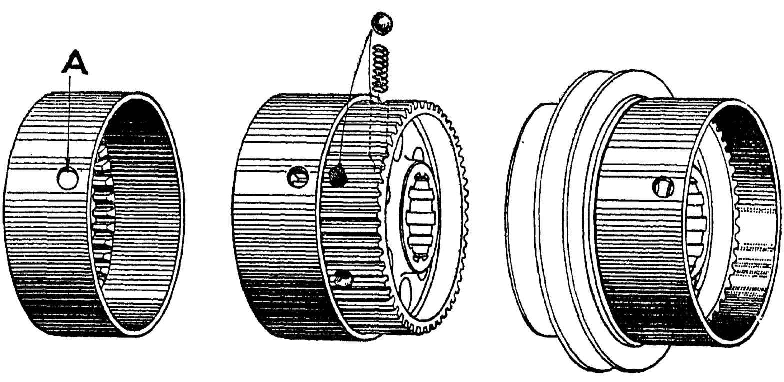


Fig. 8.—GUIDE AND DRIFT FOR DRIVING ON THE STEEL SPRING RING FOR THIRD MOTION SHAFT

motion shaft. Fit on the rear cover with a new brown-paper washer. Five setscrews of three different lengths are used, the shorter of the two longest setscrews being used opposite the reverse-shaft flange. Now fit on the front cover, taking care that the oil holes are lowermost.

If the oil seals in either the front or rear cover show signs of leaking, renew them ; they can be driven out of the covers and new ones tapped in. It must be borne in mind that it is very important that no leakage of oil, however small, should occur from the front end of the box ; the smallest amount on the clutch plate will ruin it, causing in the first place fierceness, then spin, and, if allowed to continue, eventually slip.

It has been known for a leakage to occur from under the head of the setscrews which hold the layshaft spindle bearing at the front end. This bearing has a triangular-shaped flange ; the holes for the setscrews holding this flange are drilled and tapped right through the front end of the box, and oil may leak up these setscrews and by the spring washers under the heads.



9.—JIG FOR FITTING BALLS AND SPRINGS INTO SYNCHRONISERS

It is a good practice to replace these spring washers with flat copper washers and drill the heads of the setscrews and lock them with a wire passing through all three.

The order in which the change-speed forks should be fitted is, first the first and second fork, then the top and third, and lastly, the reverse. If new parts have been fitted to the box it is possible that the change-speed forks will need a little adjustment. This is done by screwing in or out the adjustable fork rods, which are afterwards locked by their nuts to the end of the gearbox. In any case they should not be placed in exactly the same position as before because there is bound to be a little wear where the balls have passed in and out of the slots. This can easily be done by putting a mark on the screwed end of the rods relative to the old position of the ball.

When properly adjusted the change-speed lever should slightly override each gear by a small amount; this will ensure full engagement. Finally, the third motion-shaft flange should be tapped on and two gears engaged whilst the nut is tightened. New brown-paper washers should be fitted in all cases, and the greatest care taken not to bruise the teeth of any of the gears.

CLUTCH

Clutch trouble can be classified under four headings: slipping, spinning, fierceness, and noise. The present model, fitted with spring-loaded Borg & Beck clutch plate, will be dealt with, and any differences in operation appertaining to earlier models explained later.

Slipping

Slipping can be caused by oil getting to the centre plate from either the engine or the gearbox. It will be found that all the troubles mentioned can be caused by oil. Great care has been taken on the present model to ensure that no oil can escape under normal circumstances from either the engine or the gearbox on to the clutch, and very little trouble will be experienced with them. If oil is found there, look to the spring-loaded oil seal at the front end of the gearbox, and renew this if the cause of the trouble. A brown-paper washer is fitted between the crankshaft flange and the flywheel, and a rubber washer between the flywheel face and the ball-race cover plate, to prevent any grease escaping from the rear when hot. If oil is leaking from the setscrews at the end of the lay-shaft front cover, deal with them as described previously under gearbox overhaul.

It is possible, of course, for oil to get to the clutch pit when abnormal wear sets up in the engine either from oil fumes forced in by excessive "blow past" the pistons or from a leaking rear main bearing. It will, of course, be necessary to attend to these defects before a permanent cure can be made of the clutch trouble.

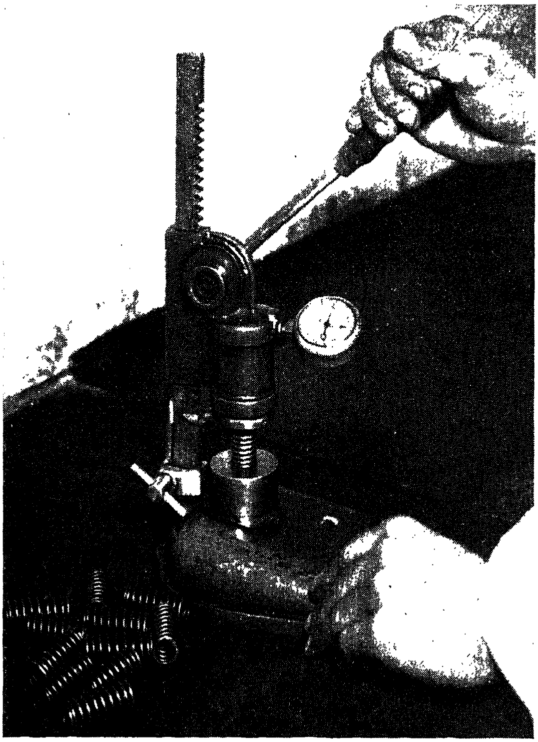


Fig. 10.—TESTING CLUTCH SPRING

When dealing with a slipping clutch the springs should always be tested; these are most inexpensive items, and it is better to fit a new set if there are any doubts. Without a spring tester it is difficult to judge the tension of a spring in its working position, and even a 5-lb. loss on each spring becomes serious when multiplied twelve times (Fig. 10). Rusty toggles can cause stiff action and clutch slip.

Spinning of this type of clutch is nearly always caused by oil on the plate. Another cause, although unusual, is a distorted centre plate. It should be tested on the splines of the first motion shaft.

Fierceness

Fierceness is also nearly always caused by a slight amount of oil getting on to the clutch. If the clutch has been badly used, slipped excessively, and the flywheel and pressure-plate surfaces badly scored, this may cause fierceness. The cure is the renewal of all worn parts.

Noise

The only noise likely to occur from the present type of clutch is a squeak from the carbon thrust ring. This again is caused by our old enemy of the dry-plate clutch, "oil." It acts in the same way as oil on a carbon brush, forming a scale. As the surface is so much larger and the pressure from the foot so much greater the noise is much louder than from a carbon brush. A cure can be effected by placing a strip of smooth emery on a foot rule or similar piece of metal, and with this cleaning the surface. There is just room enough to do this without dismantling.

Stripping, Overhauling, and Reassembling

The gearbox already being removed, knock up the lock washers and unscrew the six setscrews holding the flywheel cover and clutch assembly to the flywheel; undo these each a little at a time, so that the spring tension is released evenly.

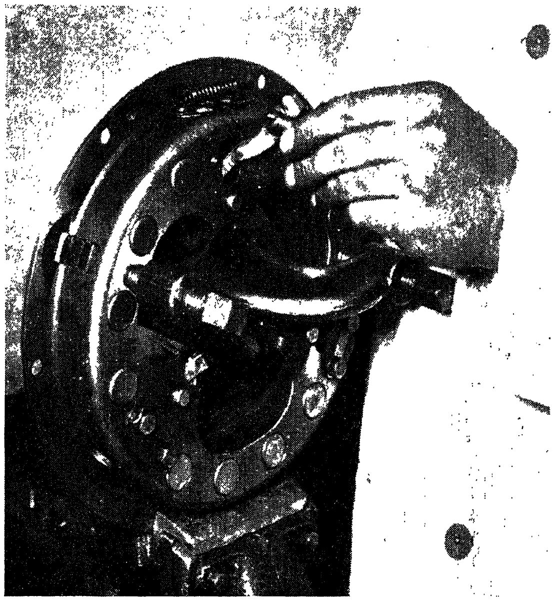


Fig. 11.—EXTRACTING CLUTCH TOGGLES, SHOWING CLAMPS IN POSITION

If there is no evidence of oil from the engine side of the clutch, and if the friction surface of the flywheel is in good condition, there is no need to remove the flywheel. If there are signs of oil coming from the rear of the flywheel, take off the flywheel and it will most likely be a percolation of oil from the joint of the crank-case rear cover.

Before dismantling the pressure-plate assembly,

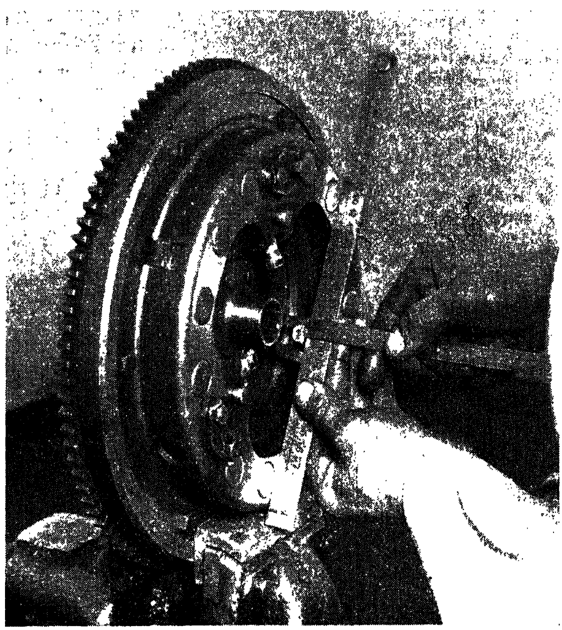


Fig. 12.—(right) MEASURING DISTANCE BETWEEN DECLUTCHING LEVERS AND TOP FACE OF FLYWHEEL COVER

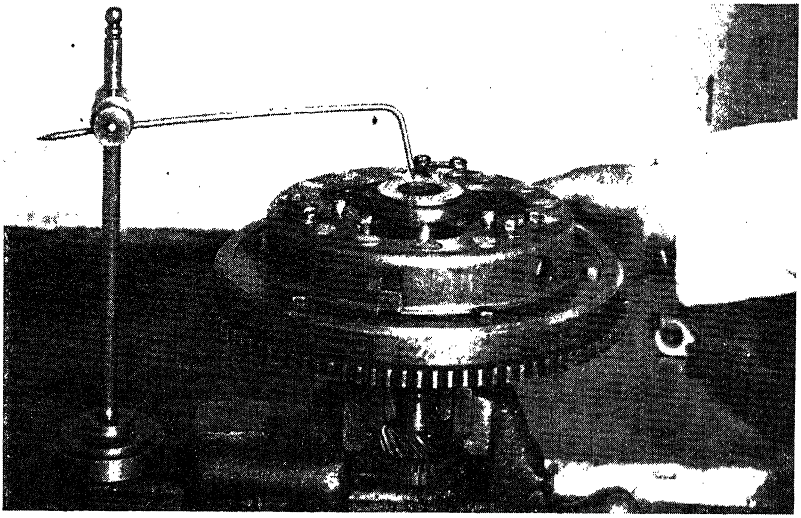


Fig. 13.—TESTING TRUTH OF WITHDRAWAL COLLAR

take out the three setscrews holding the carbon thrust in position and remove it. To dismantle the pressure-plate assembly : Use two or three clamps to compress the pressure plate. Whilst compressed, take out the screws holding the toggle seatings to the flywheel cover, remove the shims which will come away before the seatings are off, move the seatings and toggles towards the centre and they will lift out, bringing the toggle springs with them (Fig. 11). It is advisable to tie the toggle seatings and shims together in sets and mark them to go back in the same position on the assembly.

Check all parts. If the centre plate is oily, renew it. The oil cannot be washed out in any manner. When fitting a new one always bear in mind the importance of keeping it spotlessly clean ; not even oily fingers should be allowed to touch the friction surfaces. The splined centre is cadmium-plated, so there is no need for lubrication at this part. It is, however, necessary to smear the first motion-shaft splines with a little Duckham's Keenol Q 2295. This is specially prepared to withstand any chemical or atmospheric reactions which might take place if both these surfaces were assembled dry. It is possible that the new centre might be a little tight on the first motion-shaft spline. If so, use the old clutch centre and lap the first motion-shaft spline down to fit the new centre. Do not lap the new centre on the spline or the cadmium plating will be removed.

Scoring of the friction surfaces of the flywheel and pressure plate is hardly likely to be met with at all where the cast-iron inserts are used. On the previous type it is possible to skim up the surfaces to a depth of ·007 in. maximum.

Check all other parts according to the defect from which the clutch suffers; springs, toggles, toggle-pins, carbon thrust, look to the oil seal of the gearbox. Carry out the alteration to the setscrews of the layshaft-spindle bush as described in the gearbox overhaul. Make sure there is no undue slackness in the clutch-pedal shaft; one end is bushed with a greaseless bush; if the other end is worn it can be reamered out and a bush fitted in that end also.

Whilst the clutch is down, inspect the teeth of the flywheel. If these are badly worn, a reconditioned flywheel with a new starter ring can be obtained in exchange from the manufacturers. Ensure the flywheel ball race has sufficient H.S. grease, but do not overload it. Having inspected all parts and decided on the new ones necessary, reassemble the clutch, using the clamps. Complete the assembly with the exception of the clutch withdrawal collar. If the flywheel is off, the setting of the toggles can be done on the bench. Bolt the assembly to the flywheel, using three equally spaced bolts. By the use of shims the toggle seatings should be packed out until the distance between the declutching levers and the top face of the flywheel cover is $\frac{3}{16}$ in. (Fig. 12). They must all be exactly the same. Now fit the withdrawal collar; the face of this should be $\frac{9}{32}$ in. above the top face of the flywheel cover. By fitting a spindle into the flywheel ball race, and turning the flywheel complete with clutch assembly, the truth of the collar can be tested with a scribing block (Fig. 13). If not true it should be filed in the required slot where the toggle fits. Exactly the same method of checking and setting can be used if the flywheel is on the car. The engine can be turned by hand to test the collar. At the completion of this operation, remove the assembly from the flywheel, fit up complete with withdrawal-spring ring, and finally reassemble with locking plates. Make sure there is always a hole in the little plate at the bottom of the flywheel housing, otherwise condensation will take place in the clutch pit and rust up the starter, etc.

Earlier Models

Just previous to the fitting of the spring-loaded clutch plate, a Borg & Beck or Newton Bennett non-loaded plate was fitted. The operation is exactly the same for these, with the exception of a difference when setting the toggles for the Newton Bennett plate. It should then read $\frac{9}{32}$ in. from the flywheel cover to the toggles and $\frac{3}{16}$ in. from the face of the collar down to the flywheel cover.

Earlier than August 1936, the clutch liners were fitted to the flywheel and pressure-plate faces, and the centre plate was a steel one. The principles of dismantling and overhauling are the same except that the flywheel has to be taken off so that the new liners can be fitted to it. A thrust race was fitted before 1935, and this should be examined. In setting the toggles on this type, the distance from the flywheel cover to the toggles should be approximately $\frac{3}{8}$ in.

REPAIR AND OVERHAUL OF FORD CARS

THE ENGINE, CLUTCH, AND GEARBOX

By J. W. SANDERMAN, A.M.I.A.E.

THE ENGINE

THE removal, for repair and overhaul, of engines from their chassis does not present any undue difficulty in the majority of models, although a few notes as to correct procedure will facilitate this operation.

Removal of Engine from Frame

The following will apply in a general manner to all models excepting the 2-ton and 25-cwt. models, with which it is proposed to deal separately.

After removing or detaching all controls, hose connections, etc., preparatory to lifting the engine, some support must be placed beneath the gearbox and lifting slings installed to take the weight of the engine before undoing the clutch housing bolts. This is necessary owing to the power unit supports being at the front of the engine and rear of the gearbox only.

It will now be necessary to remove the engine radius rods which preserve the engine alignment on its rubber mountings. These will be found attached to either side of the clutch housing or crankcase, according to the particular model and to a chassis cross-member. When removing, careful note should be made of the side each rod is installed and the number of shims used, that they may be reinstalled in their original positions.

For convenience in handling it will be found advantageous to remove the generator assembly to which is attached the radiator fan (the fan on current V-8 cars is attached to the crankshaft), and to remove the radiator core.

This may be done without removing the radiator shell and grill, and while not absolutely necessary on the 8-h.p. and 10-h.p. models is simple to remove and gives greater manœuvring space.

In the case of all V-8 engines it is advisable to remove the distributor to avoid accidental damage; the distributor being attached by two or three screws, according to the particular model, to the front timing cover.

Lifting Engine

Lifting of engines should not be done in a haphazard manner by means of rope slings wrapped round any part of the engine, as in addition to the possibility of damage to some minor component, the engine will rarely be slung at its proper point of balance, which will only make it the more difficult to handle during removal.

Messrs. V. L. Churchill & Co. Ltd., Walnut Tree Walk, Kennington, S.E.11, the service equipment makers to Ford Motor Company Ltd., who market all the special tools mentioned in this article, have available chain slings complete with the correct lifting brackets for the various types of engines. The four-cylinder engines are lifted from the cylinder heads by means of an attachment in the sparking-plug holes, whilst special plates installed over the V-8 cylinder head studs provide the lifting attachment.

Removing Engine of Forward-control Vehicle

Forward-control vehicles are of necessity somewhat more inaccessible, but a knowledge of the correct procedure will prevent waste of time.

First remove the windscreen by detaching the opening mechanism and the top hinges, followed by the belt rail finish panel and dash cupboard in the cab. The engine cowling can now be removed and the seat and backrest taken out. It is advisable to disconnect and remove the battery complete.

Removal of the air cleaner will now permit the lifting slings to be attached ready to remove the engine after all connections, joints, etc., have been detached. The lifting tackle can now be lowered through the windscreen opening and the engine lifted and turned at right angles to rest on the floor in the nearside door opening. The lifting tackle can now be shifted to lift the engine from the floor to the bench or stand.

Taking up Wear in Big Ends

For certain repair operations it will not of course be necessary to remove the engine from the frame, particularly in the case of attention to main or big-end bearings.

In the four-cylinder engines wear in the big ends is taken up by the removal of shims from the bearing cap, and under no circumstances should this wear be taken up by filing the cap. In the case of the V-8 engine this warning is even more important, as the big-end bearings in these engines are of the floating liner type, and should apparent wear develop it will be necessary to renew these liners.

When correctly fitted it should be possible to turn the liner with a slight drag by means of a special pair of pliers which grip without damage the liner flange.

Whenever connecting rods are removed for any reason they should always be checked on an aligning jig to ensure no misalignment in any direction has taken place.

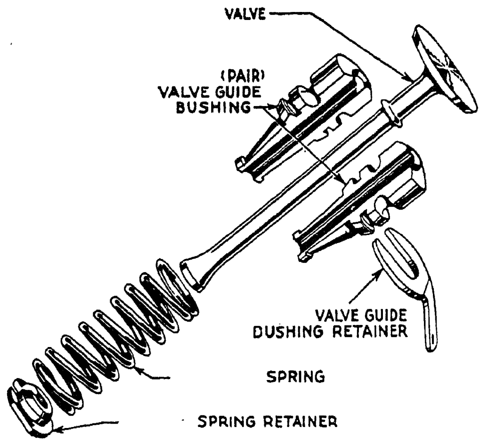


Fig. 1.—V-8 VALVE ASSEMBLY

It is not economical to remetal big-end bearings, and certainly not practicable for the repairer to true up the big-end bearing eye of the V-8 connecting rod, and it is, therefore, advised that advantage be taken of Ford Motor Company's exchange scheme on these parts, when an allowance upon the original undamaged part is made.

Taking up or Replacing Bearings

Taking up of main bearings should be done by removing shims only and not by filing the cap on 24-h.p. four-cylinder engines. All other current-type engines are fitted with thin steel-backed main-bearing liners, and if wear is apparent these will have to be replaced.

This may be done without removing the engine by first dropping the sump. The liners must be removed one bearing at a time by first taking off one cap and merely loosening slightly the bearing nuts on the other two caps. The liner half in the crankcase is now removed by means of a specially shaped copper pin inserted in the oil hole of the main bearing journal and rotating the crankshaft so that the shaped head of the pin pushes the half-liner out of its housing.

Care must be taken to see that the crankshaft is turned so that the locating tongue formed on this half of the liner comes out of the housing first, otherwise it will be impossible to remove it. Replacement of the new liner is merely a reversal of this process, ensuring that the locating tongue enters the tongue recess.

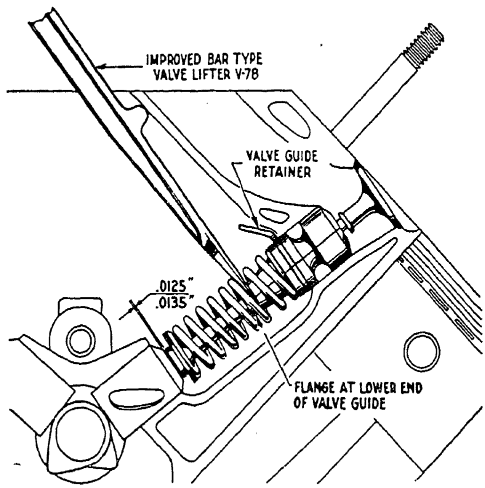
When installing main bearing liners the half with a hole drilled in it must always be fitted in the crankcase and not in the cap. This hole is for the lubrication passage and if fitted to the cap with the plain half in the crankcase will obstruct lubrication, with consequent trouble.

As the engine on which repairs are being carried out may have previously been reconditioned, make sure that the new liners are of the correct size and, in the case of the rear main bearing, of the correct length.

The end float of the crankshaft is controlled by the rear main bearing which should give approximately ·006 in. end movement.

Renewing Camshaft Timing Gears

The renewal of camshaft timing gears necessitates special precautions in that these are pressed on to the camshaft and it is only possible to be sure of obtaining the correct location of the gear in relation to the cams by the use of a special locating jig. Failure to use this jig will probably result in some slight alteration of the timing, with probably considerable adverse effect upon the running and performance of the engine.



2.—METHOD OF REMOVING V-8 VALVE ASSEMBLY

Valve Seats

Valve seats are provided with inserts of a particularly tough metal and should reseating be necessary this is only practicable by means of one of the special seat-grinding machines, after which the valve can be "lapped in" in the normal manner.

Attention to Valve Assemblies

The valve assemblies are of special construction and with the exception of V-8 engines it will first be necessary to remove the spring and collet and lift the valve as high as possible. A specially shaped drift should then be used to drive the valve guide downwards, when it will be found this is of the split bush type which will allow the valve to be lifted away from the engine. The V-8 valves can be removed as a complete assembly by pulling the *top* of the spring together with the valve guide downwards just sufficiently to withdraw a forked valve guide retainer, when the whole valve, spring, and valve guide can be lifted from the engine.

Grinding in of the valves is best effected with the use of a special dummy guide which will ensure concentricity of the valve head with the seating and working guide.

Obtaining Correct Valve Clearance

As no adjustment is provided at the tappets, the correct valve clearance must be made by grinding in the valve to reduce the gap or by grinding off some metal from the valve foot to increase the gap.

The valve foot should not be filed when making this adjustment as it is imperative that the foot should be absolutely square with its tappet, otherwise side thrust will develop which will lead to excessive wear of both guide and valve stem.

Valve clearances should be maintained at ·011 in. to ·0125 in. for inlet valves and ·012 in. to ·0135 in. for exhaust valves on V-8 engines, while 8-h.p. and 10-h.p. engines should have valve clearances of ·0115 in. to ·0135 in. for both inlet and exhaust. The 24-h.p. engines should have clearances of ·013 in. to ·015 in. for inlet valves and ·020 in. to ·022 in. for exhaust valves.

Fitting of Pistons

Pistons fitted to Ford engines are of the split-skirt type, and to ensure an accurate fit a definite "tightness" of the feeler gauge used for measuring piston clearance is specified. This method maintains the correct pressure between the cylinder walls and springy piston skirt.

In all cases a feeler gauge ·5 in. wide is used, while some form of spring balance can be used to measure the "pull" necessary to remove it. The thickness of feeler and tightness of fitting naturally vary with the type of piston, these "fits" being as follows with the feeler inserted between the thrust face of the piston and cylinder wall.

22-h.p. V-8 with aluminium pistons requires 7 lb. to 12 lb. pull to remove feeler ·0025 in. thick.

22-h.p. V-8 with steel pistons requires 5 lb. to 8 lb. pull to remove feeler ·0015 in. thick.

30-h.p. V-8 with aluminium pistons requires 5 lb. to 10 lb. pull to remove feeler ·002 in. thick.

30-h.p. V-8 with steel pistons requires 5 lb. to 8 lb. pull to remove feeler ·0035 in. thick.

30-h.p. V-8 with strutted aluminium pistons requires 4 lb. to 12 lb. pull to remove feeler ·0015 in. thick.

8-h.p. and 10-h.p. pistons require 7 lb. to 10 lb. pull to remove feeler ·0015 in. thick.

24-h.p. with aluminium pistons requires 5 lb. to 10 lb. pull to remove feeler ·003 in. thick.

24-h.p. with cast-iron pistons requires 6 lb. to 12 lb. pull to remove feeler ·004 in. thick.

Fitting Piston Pins

All piston pins are of the fully floating type and must be shrunk into the bores of all aluminium pistons.

When shrinking in piston pins it is the piston which has to be heated just sufficient for the pin to be a thumb press into position. The piston must also be heated in a uniform manner to avoid any possible distortion.

On no account should attempts be made to press in or press out piston

pins from a cold piston, as this will only result in scored piston bosses, piston pin knock due to incorrect clearances when under working temperatures and distorted pistons.

The best method of heating pistons is by means of one of the special electrical heaters with which is combined a piston pin press, but where this is not available a method often used is to immerse the piston without rings in *boiling* water for about one minute, when it should be possible to press in the pins, after oiling, without damage, the heat of the piston being sufficient to dry off the surplus water.

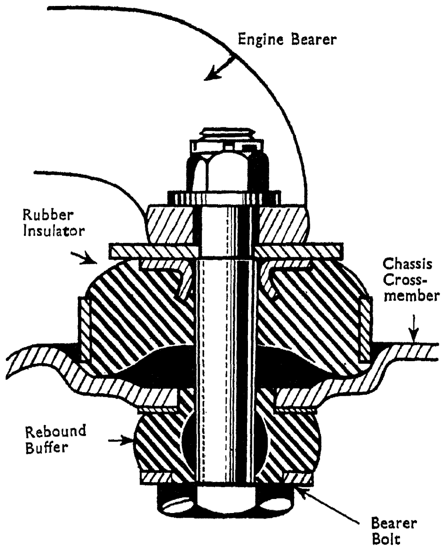


Fig. 3.—ENGINE BEARER RUBBER INSULATOR

In all cases of piston-pin fitting it is important that the piston is properly supported at the pin bosses and it is here that the electrical equipment for this purpose is of greater benefit, as the piston is clamped in a circular sleeve giving support at every point.

Where pistons are fitted with pins having a central spring retainer located in the small end bush, it is essential to use a special pilot, otherwise it may be found impossible to press the pin through the small end bush without breaking or at least distorting the spring retainer.

This pilot is in two parts and is passed through the hollow pin and screwed together. One end forms a taper pilot which enters the retainer and evenly expands it until it just passes over the pin into the retainer groove. Even where piston pins are retained by end circlips this pilot will be found of great use in lining up the connecting-rod small end with the piston bosses.

When fitting the circlip or plate-type retainers on V-8 pistons, make sure they are fully seated in their grooves and the plates are pressed right home, while when replacing piston pins make sure those of correct length are used, as two lengths of piston pins have been used in the 30-h.p. V-8 with corresponding different dimensions between the circlip grooves.

When replacing pistons do not interchange flat-top pistons with dome-top pistons and vice versa, as the heads are specially shaped for each type.

Reboring Cylinders

To ensure satisfactory reboring of cylinders, great care must be taken to maintain the alignment of the bores at right angles to the longitudinal centre line of the crank pins.

During manufacture, machining of the cylinder bores is located from the sump flange, and it therefore does not become necessary to maintain the alignment of the cylinder head face to such close limits as is necessary for the bore alignment. In view of this, where apparatus is used for reboring which is bolted to the cylinder head face on the block, alignment of the proposed cut with the crankshaft should be carefully checked, otherwise there is danger of misalignment occurring, with consequent troubles after overhaul.

Where cylinder liners have been installed it is not advised that these be replaced with other than standard liners and as these are shrunk in, pressing in of non-standard liners may not be satisfactory.

Reassembling Distributor Drive Gear

A point worthy of attention on current 8-h.p. and 10-h.p. engines is the reassembly of the distributor drive gear after overhaul. As it is not possible to reposition the distributor cam, the drive gear must be set so that the offset drive slot is in the correct position for engaging the distributor shaft.

The correct position is when standing at the near side of the engine with number 1 piston at T.D.C. on firing stroke and looking down on the drive, the slot is sloping forwards at an angle of 45° with the larger D-shaped portion facing rearwards. A similar distributor is now used on current 24-h.p. engines, necessitating the offset drive slot being set parallel with the longitudinal centre line of the engine, with the smaller D-shaped portion towards the offside of the engine.

Replacing Inlet Manifold

Another important point is never to use jointing compound when replacing the inlet manifold on 8-h.p. and 10-h.p. engines. On the flange faces of these manifolds will be seen a very fine slot which must always be kept perfectly clear, and if jointing compound is used will squeeze into these slots and disturb carburation.

Engine Mounting

All engines are supported on rubber insulators, alignment being preserved by engine radius rods. Before these rods are finally tightened up the engine must be in correct alignment, and tightening of the rods must not put any stress on either side but must just hold the engine in the correct position, using shims to take up any space between the engine or chassis member and locating faces on the radius rod.

Correct mounting of the rubber engine support insulators is important. It will be found that the bolt hole in the engine support feet is larger than

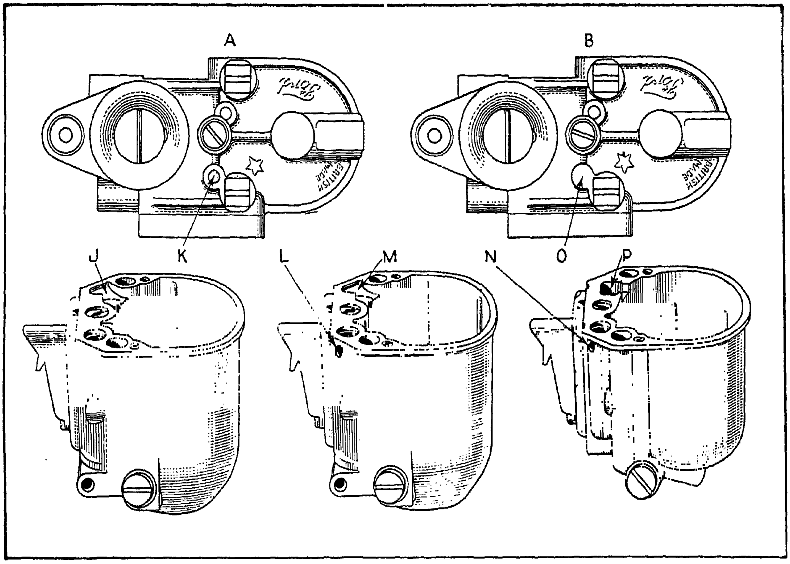


Fig. 4.—8-H.P. AND 10-H.P. CARBURETTOR BOWL AND COVER COMBINATIONS
Bowl vents, J, M and P. Air-well vents, K, L and N. No air vent drilled in cover, O.

the special support bolt, and care should be taken that when finally tightened down against the shoulder no metal-to-metal contact should be made between the bolt and the support bracket feet.

These insulators consist of two parts, one main rubber support on top of the chassis member and a smaller rebound buffer below the chassis. When correctly assembled the tension on the lower buffer should be just sufficient to cause the sides to bulge slightly. If this buffer is squeezed up hard, possibly an incorrect bolt or washer is being used, in which case the correct parts must be installed, or if no tension is placed on it the top rubber support is probably perished and should be replaced.

CLUTCH AND GEARBOX

Dismantling Clutches

All clutches are of the single-plate, dry-disc type and do not present any difficulty in dismantling.

No attempt, however, should be made to adjust the clutch release fingers, as should the pressure plate not be withdrawing squarely this would point to either broken or weakened pressure springs and no adjustment would make a satisfactory cure.

In addition to this, the withdrawal fingers are carefully adjusted and balanced during manufacture to preserve the " squareness " of operation, and any attempts at adjustment will only result in unsatisfactory conditions.

Should trouble be experienced with the pressure plates it is far better and more economical to fit an exchange assembly.

Relining Clutch Friction Plate

The question of relining the clutch friction plate may arise in course of service either because of wear or of oil-soaked friction material.

It is useless in the latter case to attempt to clean the friction material of oil by washing or burning off; new linings being the only certain cure. In the case of this component it is also far more economical to exchange the original plate for a reconditioned one which has been overhauled down to the last rivet.

8-h.p. and 10-h.p. clutches comprise two plates assembled after the linings have been fitted, so that attempts to reline them in service is not recommended as there is great danger of the plates being cracked or severely strained.

Inspecting Friction Plates

A careful inspection should always be made of friction plates to see whether any of the hub rivets have loosened or whether the hub splines are worn. In either case it is advisable to fit an exchange plate; attempts at tightening rivets will always be unsatisfactory as in all probability the rivet hole has become distorted.

Reassembling Clutches

In reassembling the clutch a combined compressor and locator should be used. The locator is essential to correctly centralise the pressure plate before bolting up. If this is not done there is the possibility that it may be assembled slightly out of centre and give rise to a vibration when running on the road.

Dismantling Gearboxes

Overhaul of gearboxes is a straightforward job, and few special precautions are necessary. On gearboxes fitted with synchromesh the most convenient method of dismantling is to drive both the mainshaft with bearing and the main drive shaft and gear with bearing out of their housings from the inside and then lift out the synchromesh unit complete. The two bearings can then be drawn off their shafts and the shafts lifted out of the top of the box.

Dismantling of the synchromesh unit requires a special jig on which the unit is placed and the hub driven down into the jig. This retains the six spring-loaded locating balls and also permits reassembly without difficulty in entering the six balls into the outer shell.

Loose or worn friction cones cannot be replaced and it then becomes necessary to renew the complete hub. On no account must the outer shell be moved when the gearbox top is off, while the top should not be detached unless the gear lever is in the neutral position, otherwise the

locating balls and springs may drop into the box and necessitate complete dismantling.

A final important point is always to see that the tongued washer under the screw securing the universal joint to the mainshaft is correctly installed with the tongue in one of the splines. The universal joint controls the end float of the mainshaft, and if the washer is incorrectly located excessive end float and faulty synchromesh action will result.

CARBURETTORS AND FUEL SYSTEM

Carburettors should present little trouble, but should carburation appear unsatisfactory it is not advised that jets be altered as the trouble will not be in jet sizes provided no attempts have been made to ream out or otherwise enlarge the jet orifice.

Checking Petrol Levels

Petrol levels are more important and should be checked if carburation is suspected. Petrol levels are controlled not only by the setting of the float and needle valve but by the pressure of fuel delivered by the pump, and this pressure should always be checked before making any adjustment to the carburettor.

The petrol levels for the various types are as follows: In the early type carburettor on 24-h.p. engines the petrol level should be $\frac{5}{8}$ in. from the top of the float bowl, and on the later type updraught carburettor approximately $\frac{1}{64}$ in. below the beak of the emulsion block.

In the early single-port V-8 carburettor the fuel level should be $1\frac{3}{16}$ in. from the top of the float bowl and $\frac{15}{32}$ in. from the same point in later dual-port carburettors. A special gauge is available to check this.

The carburettors fitted to 8-h.p. and 10-h.p. models should have a petrol level $\frac{1}{64}$ in. below the beak of the emulsion block.

Points to Observe in Assembling Carburettors

When assembling the 8-h.p. and 10-h.p. carburettors and the 24-h.p. updraught carburettor the beak of the emulsion block should be just clear of the vaporising bar in the choke tube. Should the emulsion block gasket be incorrectly assembled or a thicker non-standard gasket be used, the beak will foul the bar and prevent correct assembly of the float bowl.

This will only be slight and may pass unnoticed, but may be sufficient to alter the petrol level and upset carburation.

With the early type 24-h.p. carburettors a dash-controlled needle valve is provided for temporarily enriching the mixture when starting from cold. When the engine is running normally this should be screwed right in and should effectively shut off the flow of any additional fuel.

During overhaul this needle valve should receive attention to see that not only does it screw right down on to its seating but that the seating and the needle cone are undamaged, otherwise a continual leakage will occur at this point.

It may sometimes be found that due to some burr or foreign matter the needle will appear to be screwed fully shut although actually it is slightly open and, in this case, it will be necessary to make it quite free. Should for any reason continual leakage occur at this point both heavy petrol consumption and unsatisfactory running may result, while should reasonable running be attained only with this valve open this would indicate some derangement or inefficiency in the engine itself, which should be rectified.

Minor Modifications in 8-h.p. and 10-h.p. Carburettors

Minor modifications in 8-h.p. and 10-h.p. carburettors make it necessary to be careful in replacing parts to ensure correct assemblies are made.

In the original type of carburettor a hole was drilled in the float chamber cover, adjacent to one of the securing bolts, and was covered with a gauze filter. This hole was connected with an air well, and it is essential that the gauze should always be in place and in good condition, also that it is quite clear and free from dirt.

If the gauze becomes blocked erratic running will result, while if dirt is allowed to enter the air well it may find its way into the fine passages in the emulsion block, with the same results.

In later carburettors the air hole will be found in the side of the float bowl, and the gauze filter and drilled hole in the cover are dispensed with.

It is obvious that these parts must not be interchanged, and the undrilled cover must be used only where the bowl is provided with an air vent in the side.

These various combinations can be clearly seen in the illustration Fig. 4.

Easy-starting Control

Earlier carburettors were also provided with an open well above the starter jet and a spring-loaded automatic air valve to the easy-starting device, which was replaced in later carburettors with a calibrated "diptube" in the starting-jet well, and the air valve removed, so that it is not advised to use a diptube bowl with a carburettor provided with the automatic air valve, and vice versa.

When connecting up the easy-starting control on these and the 24-h.p. updraught carburettor, adjust this so that not only is the easy-starting valve fully opened when the control is operated, but there is sufficient slack left to prevent movement of the engine on its rubber mountings, causing intermittent opening of the valve with consequent excessive petrol consumption.

Hydrostatic Petrol Gauge

In the earlier type fuel systems a hydrostatic petrol gauge was used. These rarely gave trouble, any failure to register usually being due to

minute air leaks in the line connecting the gauge to the tank unit or in the unions. If, however, any of the recording fluid is lost this should only be replaced by the special fluid supplied by Ford Motor Company Ltd., as the accuracy and correct operation of the gauge depends upon the specific gravity of the fluid used.

Cause of Erratic Operation

Erratic operation of this gauge will probably be caused by a small globule of moisture which condensation has caused in the air line. This can be cleared by blowing through with a hand tyre pump. Do not use a compressed-air plant as air thus provided always contains a certain amount of moisture.

SERVICING PACKARD SIX, EIGHT AND SUPER EIGHT, 1937-9

ENGINE, CLUTCH, AND GEARBOX

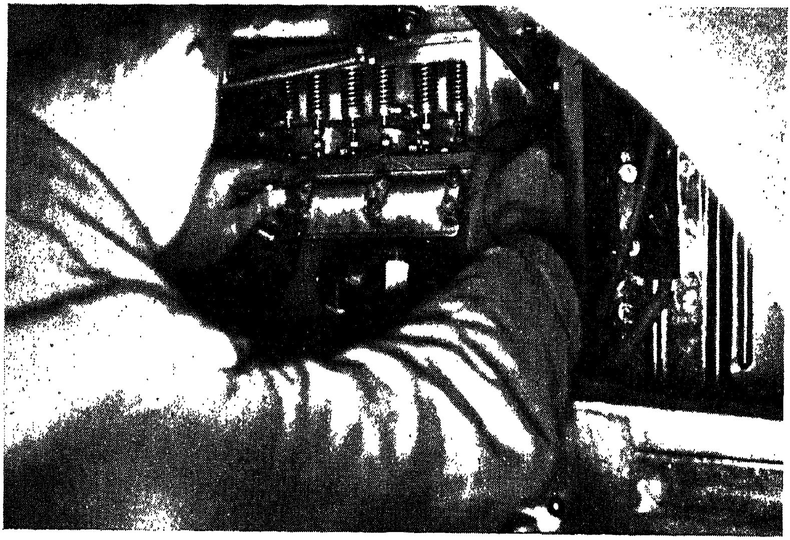


Fig. 1.—TO ADJUST THE VALVES FROM UNDER THE WING THE CAR HAS TO BE JACKED UP

FEW differences are apparent between 1937, 1938, and 1939 models of the Packard Six and Eight. Almost identical, apart from the number of cylinders, the Six and Eight represent typical American practice in the medium-price class. The Super Eight, although rated at a lower horse-power, has a much larger engine with a long stroke, and is designed on entirely different lines as a quality job in the high-price range.

For 1938 the bore of the Six was increased, raising the horse-power rating from 29 to 30, and 12-volt electrical systems were adopted throughout the range. Other minor modifications are referred to under the appropriate headings.

Special tools, though not necessary for ordinary routine service, in many cases facilitate dismantling and are obtainable from the concessionaires, Leonard Williams & Co. Ltd.

ENGINE

Mounting

Mounting is of the three-point rubber type. At the front an inverted U-shaped member is bolted direct to the front cross-member at each end, carrying the engine at centre on a rubber block bolted to the cylinder block.

The brackets bolted to each side of gearbox bear at an angle on rubber blocks. On some 1937 models a stabiliser is fitted, consisting of two overlapping steel strips bonded with rubber bolted between rear of gearbox and cross-member to take clutch thrust. All bolts should be fully tightened, there being no adjustment for tension.

Removal

Take off radiator and front wing assembly in one piece and gearbox lid and lever, disconnect all pipes, wires, and controls, take weight of engine on slings, and remove bolts attaching front bearer to cross-member and bolts of rear mounting brackets. The engine gearbox unit can then be lifted out forwards and upwards.

Cylinders

On models Six and Eight the cylinders are cast in one with the crankcase, with a flat sump flange below crankshaft centre line. On the Super Eight the cylinder block is separate from the aluminium crankcase and sump.

Crankshaft

There are four main bearings on the Six, five on the Eight, and nine on the Super Eight. These are thin-wall, steel-backed, white-metal liners located by tabs at end, and are of the precision type. No fitting is permissible.

If necessary, bearing shells can be renewed without removing crankshaft by slacking off all caps slightly and removing one at a time, pushing the top half of bearing shell round by turning shaft with soft plug in oil hole.

Front and rear main bearing caps are recessed in the crankcase with hardwood inserts as oil seal.

The flywheel is bolted to flange at the rear end, and the starter ring is shrunk on. Tooth ratio : Six and Eight, 140 : 9 ; Super Eight, 148 : 9.

The torsional vibration damper is bolted to the pulley at front end, keyed and held by bolt in end of shaft. The pulley boss passes through the oil seal on timing cover.

Connecting Rods

Big ends are of the same type as main bearings. Caps must not be filed. The rods are rifle-drilled for small-end lubrication on the Super

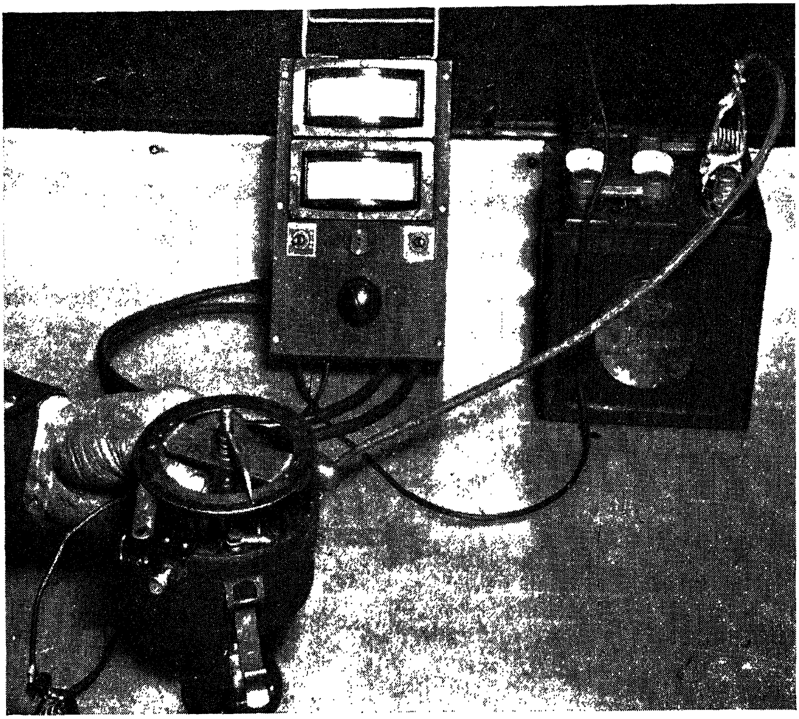


Fig. 2.—SYNCHRONISING THE DISTRIBUTOR

Eight. The small ends are bronze bushed, and the gudgeon pins are of the floating type and are a finger-push fit in the bush.

Pistons

The autothermic aluminium alloy split-skirt pistons are cam-ground and tin-plated. A feeler 0·0015 in. thick and $\frac{1}{2}$ in. wide, inserted against thrust face on opposite side to slot, should require 8–11 lb. pull to withdraw, or 3–5 lb. in the case of the Super Eight.

Oversize pistons are available 0·005 in. over, and in 0·010-in. steps to 0·040 in. on Six and Eight. For Super Eight, sizes available are 0·003 in., and from 0·005 in. to 0·035 in., in 0·005-in. steps, also 0·045 in.

There are three rings, two $\frac{1}{8}$-in. compression and one $\frac{3}{16}$-in. oil control, on the Six and Eight. The Super Eight has an additional oil-control ring, both being $\frac{5}{32}$ in. wide. Gap, 0·007–0·015 in.; side clearance in groove, 0·002 in.

Piston and connecting-rod assembly can be removed through top of cylinder.

Gudgeon pin should be finger-push fit in piston at 160° F. For dismantling and assembly the piston should be heated.

Assemble the piston on connecting rod so that big-end oil bleed hole and piston slot are towards camshaft. Top and third rings should have gap away from, and second and fourth (on Super Eight) towards, camshaft.

Camshaft

This is on the offside, and is driven by an inverted tooth chain at the front of engine, and requires no adjustment. Bearings are white-metalled thin steel bushes. The end float is controlled by the flange of front bearing bolted to crankcase. Running clearance is 0·001–0·003 in. on Six and Eight, and 0·0015–0·0035 in. on Super Eight. End float is 0·002–0·004 in.

To dismantle or renew the chain, remove both sprockets and chain together. The same rules apply for assembly. Timing marks on wheels should be opposite and in line with centres of shafts at T.D.C.

Valves

Valves are arranged side by side, and are not interchangeable. Fixing is by slot and key. Single springs are used on the Six and Eight, and double-coil springs on the Super Eight.

Valve guides are renewable. There is no shoulder. Press in until the top of guide is $\frac{23}{32}$ in. below the top face of the block.

Tappets

On Six and Eight, these are cylindrical and are fitted direct in block. Remove from above. On Super Eight detachable guides have flange trapped between block and crankcase. There is a nut and locknut adjustment on the tappets.

Rockers

Tappets on the Super Eight are actuated by rockers with rollers bearing on the cams. The rockers are mounted on two shafts carried in inverted troughs bolted to the outside of the crankcase.

Lubrication

A gear-type pump is mounted on the outside crankcase on offside on Six and Eight, and a relief valve with fixed-tension spring is provided at the side. Normal oil pressure is 35 lb. at 30 m.p.h.

The pump-drive housing is spigoted in the crankcase, and carries a skew gear on the end of the shaft with dog for distributor drive on nearside.

A large gauze bowl filter on the pump intake is bolted to the bottom of the crankcase separate from the pressed-steel sump. Oilways are drilled in the crankcase, and delivery is direct to gallery on the offside, with lead to Purolator pressure filter on the nearside.

On the Super Eight model the pump is submerged in the aluminium sump and driven by a vertical shaft. The sump need not be removed for



Fig. 3 (*left*).—LOADING TOGGLE ADJUSTING SCREWS

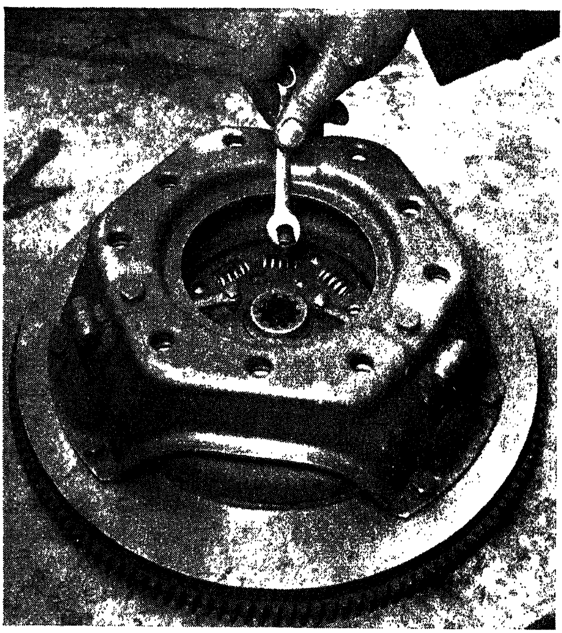
access to pump, a detachable plate being provided immediately below the pump. Oil is fed to the main bearings by pipes after passing through temperature regulator bolted to block and connected to water inlet from radiator.

The relief valve is adjustable to give 5 lb. idling pressure and 55 lb. maximum.

Fuel Feed

The fuel feed takes the form of an AC mechanical pump on off-

Fig. 4 (*right*).—ADJUSTING THE TOGGLES



side combined with a vacuum booster pump for windscreen wipers. In case of complaints of over-oiling, make sure that the vacuum pump diaphragm is not punctured ; in such a case, oil is caused to be drawn into the engine via the induction manifold, and is indicated by the presence of oil in the pipe from manifold to pump when disconnected.

Carburettor

On the Packard Six the carburettor is of the Chandler & Groves down-draught type with accelerating pump, suction economy device, and thermostatic choke control.

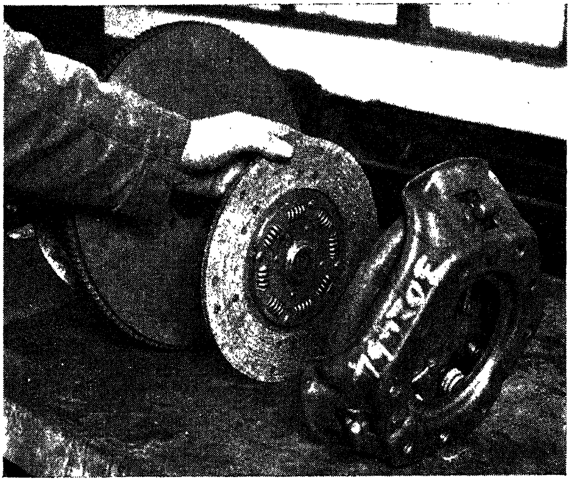


Fig. 5.—CLUTCH ASSEMBLY
Note which way centre plate is facing.

The only running adjustment is for idling. Turn the throttle stop screw to slow idling speed with engine warm; turn the slow-running mixture screw on side of carburettor out until engine begins to "roll," then in again until smoothest running is obtained. Reset throttle stop screw if necessary to give proper idling speed. Do not attempt to secure very slow idle.

Check float level, which should be $\frac{17}{32}$ in. below top face of bowl with $2\frac{1}{2}$–3 lb. pressure on fuel. Free end of float should be $\frac{3}{16}$ in. below top of bowl.

If choke sticks, disconnect linkage and check for freedom. Ease bearings if necessary, but do not oil.

Eight and Super Eight models are provided with a Stromberg duplex carburettor. Idling adjustment procedure is similar to the Six, except that two mixture screws are used, one controlling middle four cylinders, the other affecting both end pairs. Adjust one at a time, and turn outwards to increase richness.

Fuel level should be $\frac{15}{32}$ in. below top of bowl in Eight and $\frac{5}{8}$ in. on Super Eight.

Air Cleaner

The AC oil bath should be removed every 5,000 miles. Take out the filter element and reservoir, and clean the filter in petrol or paraffin (do not oil). Empty reservoir, clean out, and refill with 1 pint of engine oil.

The crankcase breather on oil filler should also be cleaned in petrol every 2,000 miles and soaked in engine oil before refitting.

Ignition

A Delco distributor with automatic centrifugal and vacuum control is fitted on the Six. Advance range on centrifugal is $9\frac{1}{4}°$–$10\frac{3}{4}°$; on

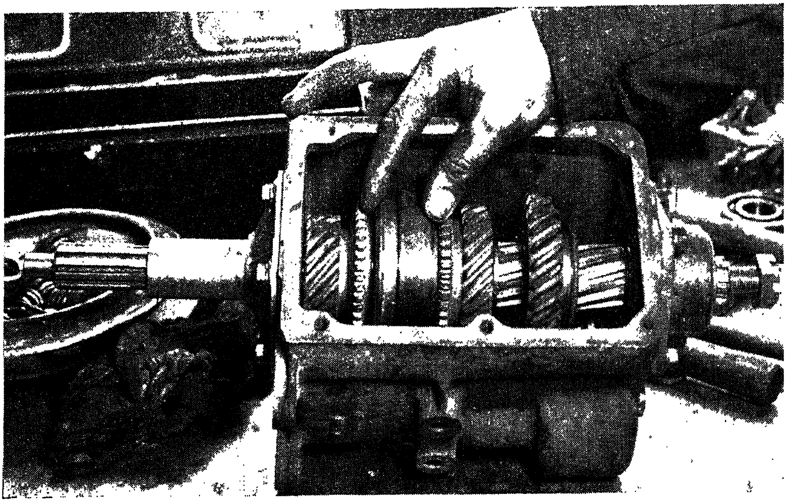


Fig. 6.—THE GEARBOX ASSEMBLY
Showing syncromesh gear.

vacuum, 7½°. Time points to break at 4½°–6° before T.D.C., or 2–3 graduations on flywheel scale, visible through inspection hole below starter. Engines with aluminium head and 7 : 1 compression ratio should be timed 2½°–4° (one or two graduations on flywheel) before T.D.C. See that fuel compensator is at zero before setting the timing.

The Eight is fitted with an Autolite distributor. Timing is 6½°–8°, or 3–4 graduations in flywheel before T.D.C. Advance range 8¾° on centrifugal and 6° on vacuum.

An Autolite distributor is also fitted on the Super Eight. Timing is 6°–8° before T.D.C. (6–8 graduations of scale on vibration damper at front end of crankshaft, pointer on timing cover). With high-compression heads, set at 4°–6° before T.D.C. Advance range 8°–10° on centrifugal, 7½° on vacuum.

Plugs are 10-mm. size and should be carefully handled. Tighten with a small box spanner, using one hand only on tommy-bar not more than 4½ in. long.

Cooling System

The cooling system consists of a pump, fan, and thermostatic control. The 1937 Six and Eight models had thermostat incorporated in the water outlet. The Super Eight for 1937–8, and the 1938 Six and Eight, have thermostatically controlled radiator shutters.

Pumps on the 1937 Six and Eight had composition bushes and continuous ring adjustable packing. To replace packing, remove the fan and pulley, cut away old packing, and replace with split type.

On 1938 cars a packless gland is used with a spring-loaded rubber seal and composition thrust washer. The spindle runs in a double-row ball bearing in the oil reservoir. To renew seal, dismantle the pump. Heating in nearly boiling water will help when pressing out impeller. When replacing the thrust washer, see that the convex face is towards fan blades.

The Super Eight pump has adjustable packing, and spindle runs in two ball bearings with felt packing, which should be saturated in engine oil on reassembly.

Dynamo Drive

This is of the triangulated-belt type with water pump and fan. Adjustment can be made by swinging the dynamo so that "give" is about ½ in. between dynamo and fan pulley.

TRANSMISSION

Clutch

Borg & Beck semi-centrifugal clutch is 9½ in. on the Six and 10 in. on the Eight. Toggles are mounted on the needle rollers. The only adjustment is on end of clutch-operating arm to give 1½–2 in. free movement at pedal pad.

Bell housing on the Six and Eight is box casting bolted inside to crankcase, with detachable bottom cover. To remove the clutch, take off gearbox and fix clutch in partially released position by wedges between the outer ends of toggles and cover. Clutch can then be dropped through the bottom after removal of operating arm.

Gearbox

A three-speed gearbox, with synchromesh on top and second, is incorporated on Packard cars.

To remove, disconnect propeller shaft, cable and bell-housing bottom cover (Six and Eight). Support the rear of engine and remove bolts of support brackets each side of gearbox. Remove one bracket from frame. On Six and Eight, undo the four bolts holding gearbox to bell housing. On Super Eight, undo nuts round flange of bell housing, which is part of gearbox casting. The box can then be pulled off.

When dismantling the Six and Eight, remove the universal flange, speedometer pinion, rear end plate, layshaft locking plate, and front end plate. Drive out the layshaft spindle rearwards. Drive out the primary shaft with bearing forwards and mainshaft rearwards until bearing is released from box, then lift the mainshaft assembly out through top of box, pick out layshaft cluster, and drive out reverse idler spindle rearwards.

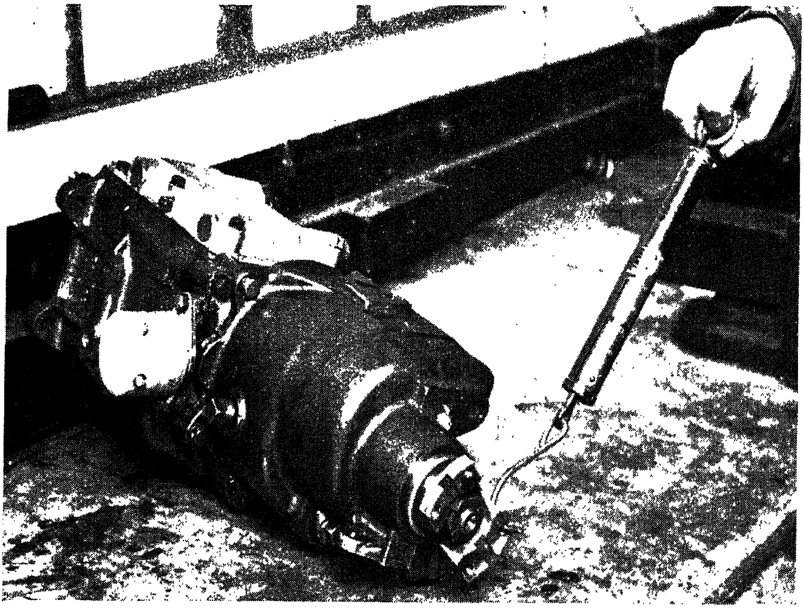


Fig. 7.—PRELOADING TEST ON OVERDRIVE

Do not attempt to dismantle the mainshaft assembly, which is only serviced as such.

On reassembly, put in the layshaft cluster before fitting reverse idler. The cluster should be a free fit in the box without perceptible end play. See that bronze thrust washers at each end of the layshaft have lugs in line with the corresponding slots in box before fitting.

Dismantling the Super Eight : Here a different type of synchromesh is used, in which top- and second-gear dogs are moved directly by selector fork while synchromesh cones are moved by yoke passing under mainshaft, centralised by two opposed springs on nearside and operated by spring-loaded plunger bearing on selector rod.

Movement of the synchroniser yoke is important for securing quiet change, and should be 0·140–0·160 in., measured on rear face of that part of yoke containing centraliser springs. This automatically ensures proper clearance of 0·018 in. between synchromesh cones. Adjust by shims in front of mainshaft rear bearing or behind primary shaft bearing. A 0·006-in. shim will affect yoke travel by about 0·040 in.

To dismantle, remove the gear-lever turret, top cover, and stop-light switch. Take out selector fork screws and pull out rods rearwards one at a time. Selector balls and springs are recessed in box below rear end of rods, with interlock ball between. Remove the front bearing cover, the nut from front of layshaft spindle, and the universal joint yoke and rear

bearing cover. Take out synchronising yoke screws, one on each side of box, and centralising screw (nearside). Undo primary shaft bearing nut, and drive out layshaft rearwards and primary shaft forwards.

Drive the mainshaft back until the bearing is released from box, then align one slot in sliding dogs with synchronising yoke and remove top-gear cone, yoke with bronze links, dogs, and second-gear cone through top of box. Move the mainshaft forward until first and reverse sliding gear and splined sleeve can be slid off and shaft removed through top with second- and first-speed gears in place. Lift out the layshaft cluster, remove reverse idler spindle locking screw on nearside of box, and drive out the spindle rearwards.

On reassembling, " L " mark on flat at front of layshaft must face towards reverse idler gear. See that the bronze synchroniser yoke links are replaced the right way up. The word " top " is cast on links.

Propeller Shaft

The joint is of the needle roller, sealed type. Dismantle, repack with grease, and fit new seals every 30,000 miles.

REPAIR NOTES ON S.S. JAGUAR CARS

ENGINE, CLUTCH, AND GEARBOX, 1½-, 2½-, AND 3½-LITRE MODELS

By D. H. WARREN

ENGINE

General Tuning Instructions

ASSUMING there is no loss of compression due to worn pistons or burnt valve seats, one of the first steps in tuning is to check the valve clearances. These as applied to the Jaguar models are tabulated hereunder :

1936/7 1½-litre Jaguar up to engine No. 302201 = ·004 with warm engine.

From engine No. 302201 and upwards = ·012.

1936/7 2½-litre Jaguar = ·004.

1937 2½-litre Jaguar after engine No. 251751 = ·012.

1938/9 2½- and 3½-litre models = ·012.

The tappet clearances for each cylinder should be checked and adjusted when the piston is at the top of the compression stroke. On six-cylinder models this is best found by the following method : Numbering from the rear the cylinders operate in pairs, that is, 1 and 6, 2 and 5, 3 and 4. By means of the starting handle turn the engine until the valves on No. 6 cylinder are just rocking, that is, exhaust valve just closing and inlet valve just opening. Both the rockers on No. 1 cylinder are then ready for adjustment, and the operation is then repeated for the remaining cylinders as follows :

No. 4 valves rocking—adjust No. 3 cylinder.
No. 1 valves rocking—adjust No. 6 cylinder.
No. 5 valves rocking—adjust No. 2 cylinder.
No. 3 valves rocking—adjust No. 4 cylinder.

Sparking Plugs

Recommended sparking plugs for all Jaguar engines are the Champion L.10, or the rather cooler type Champion L.A.10 for S.S. 100 or Saloons being driven exceptionally hard. Sparking-plug points should be set to ·018 in. and distributor contact-breaker points to ·012 in.

Timing Adjustments

Before making any timing adjustments it is advisable to check the distributor governors and to make sure that they are operating freely. Under no circumstances should the governor spring tension be altered in any way.

Owing to the high compression ratio these engines will be found particularly sensitive to ignition timing, and it is therefore found best roughly to set the timing and to make final adjustments while on road test, the best distributor setting being found by trial and error. Naturally, due regard must be taken of the owner's methods and conditions of driving, also the type of fuel used. In all cases it is practically essential to use a fuel such as Ethyl or Discol, as a straight petrol or benzol mixture will give rise to excessive pinking. Excessive pinking may, in some cases, be caused by erratic ignition timing due in turn to end float in the distributor driving pinion. Steel shims may be inserted between the pinion spindle and body to take up end float.

Carburettor Tuning (all six-cylinder models)

The engine should firstly be run-up to a minimum temperature of 60°, and as it is desirable to adjust each carburettor independently the throttle butterfly connecting-rod should be slackened off at one end. The throttle butterfly stop-screws may then be adjusted until an equal hissing sound is audible from each air intake, and a convenient method of doing so is to use a long cardboard tube, one end being held to the ear and the other close to the carburettor intake. For this purpose the air filters, if fitted, must be removed.

Next, the jet adjusters should be dealt with in turn and adjusted either way until the engine is running evenly and at an idling speed of 500 r.p.m. to 600 r.p.m. The jet adjusters on 1936 models are the outside hexagon nuts, and it is usually necessary after making adjustment to reset the choke-control linkage. The jet adjusters on all later models are set-screws found underneath the jet cover dome nut, but, in either case, adjustment in an upward direction weakens the mixture and vice versa.

It is also advisable to check-up on the action of the carburettor pistons, as any tendency to stick will completely upset carburation under working conditions.

Later 3½-litre models have oil-controlled dashpots which must be kept filled with oil.

Adjustment of Automatic Choke

The choke-mixture strength is controlled by the starting needle, the movement of which is restricted by stop-nut. The original setting is best made with warm engine, when the choke can be brought into action by shorting the thermostatic switch with a piece of wire, then temporarily

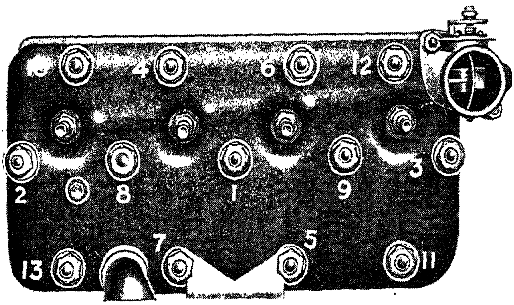


Fig. 1.—CAST-ALUMINIUM CYLINDER HEAD (1936–7 MODEL)

Showing sequence for slackening off and tightening holding-down nuts.

opening the throttle so that the resultant depression in the induction will allow the solenoid to operate and open the starting carburettor passage. The stop-nut should be adjusted until the engine runs without undue hunting at a speed of about 1,200 r.p.m.

If, when attempting to start from cold, the choke does not operate, the fault is most probably in the thermostatic switch, which may be temporarily shorted for test purposes. It must be noted that the switch should automatically cut-off the choke when the engine reaches a temperature of 35°–40°.

Carburettor Settings

1936 2½-litre.—R3 or No. 5 needles. 1937 2½-litre.—R.O. or No. 62
-litre.—No. 2 needles. 1938 3½-litre.—No. D.7 needles.
½-litre.—No. C.Y. needles. 1938 1½-litre.—No. 7 needles. 1939 1½-litre [horizontal S.U.].—E.1 needles.

1937 1½-litre Solex carburettor :

Choke	29
Main jet	130
Correction	2·2
Jet well, No. 6	

1936 1½-litre Solex carburettor :

Choke	30
Main jet	135
Correction	240
Jet well	

or alternatively, for economy—

Choke	28
Main jet	125
Correction	290
Jet well	6 mm.

Decarbonising Six-cylinder Models

The dismantling operation is quite straightforward, first of all taking off rocker assembly, top hose, carburettors, and manifolds. On all

2½-litre models the vertical revolution counter and oil-pump drive shaft should be lifted out before raising the head, to prevent damage. This shaft is keyed on to the skew-driven gear off the camshaft, the key being a tight fit in the shaft. After removing the head replace the oil-pump drive shaft into position, as otherwise, if the engine is turned by hand, the idle gear will jam and damage the camshaft gear. Valves and seats have 30° faces and are re-seated and ground in by usual methods.

On all six-cylinder models except early 1936 models from car Nos. 10001 to approximately 10500, that is, those engines with adjustable push rods, corrujoint thin sheet nickel gaskets are employed, and it is advisable to renew them on each occasion when the head is removed for any purpose. Under no circumstances should a C. & A. gasket be substituted, as by so doing there is a risk of causing cylinder-block distortion.

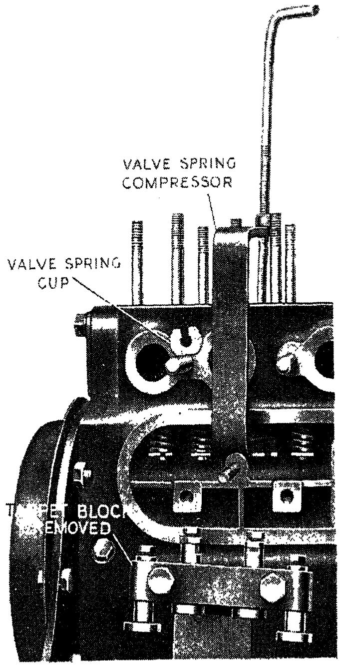


Fig. 2.—REMOVAL OF TAPPET BLOCK, VALVES AND SPRINGS (1½ LITRE, 1936–7)

If, for any reason, the owner wishes to lower the compression ratio, special cylinder heads are, in many cases, obtainable by application to the factory. Jointing compound should be used on the corrujoint gasket, and care taken in sealing both extreme offside corners.

On reassembling the head and refitting the oil-pump drive shaft, the latter should be allowed ·006-in. end float, adjustment being provided by shims placed underneath the top retaining bush. Care should also be taken to put back the hardened-steel thrust washer which is fitted on to the shaft immediately above the circlip. After refitting the cylinder head, the holding-down nuts should be finally tightened down when the engine has been given a short run.

Decarbonising 1936/7 1½-litre Models

The cast-aluminium cylinder head should not be disturbed until the engine has cooled off, and the holding-down nuts should be slacked off in the sequence shown in Fig. 1, which is the same for retightening on assembly. The decarbonising operation is, of course, the same as on the average side-valve engine, but to facilitate removal of the valves the tappet blocks complete with tappets should be taken out by withdrawing the attachment bolts (see Fig. 2). The valves and springs are then readily

accessible and can be removed with the use of a suitable extractor. The cylinder-head studs and holes in the head should be cleaned out.

When reassembling, care should be taken in pulling down the cylinder-head nuts in proper sequence, and in replacing the distributor, the drive shaft of which may have been lifted out of engagement with the dog in the oil pump. The distributor adaptor bracket should be carefully tightened up, also the distributor-body locating screw and locknut.

Piston and Connecting rods

On all models except 3½-litre the pistons and connecting rods may be withdrawn from underneath after removing the sump. On 3½-litre models, as there is insufficient room to draw the pistons past the crankshaft, it is necessary to also lift the cylinder head, so that the piston and connecting rod complete may then be passed up through the bore.

Piston-ring gaps should be set to ·004 in., and piston clearances on the thrust side of the skirt are ·002 in. when new. The pistons are oval in shape, with the smaller radii on the gudgeon-pin side and the top lands. Gudgeon pins are fully floating and are fitted with end pastels or circlips. 1938/9 models of the 1½- and 3½-litre class have steel connecting rods with phosphor-bronze small-end bushes.

On all models up to 1938, when fitting new big-end bearings, a little hand-scraping and bedding-in is necessary, and in the case of early 2½-litre models new big-end bearings may be ⅛ in. narrower than the originals. These bearings are, of course, quite interchangeable, and the smaller bearing surface is in effect quite immaterial. 1938/9 models are fitted with precision steel-backed bearings which must not, under any circumstances, be scraped, neither should the connecting rod cap be let down. New bearings as necessary are merely fitted into the rod, without even disturbing the piston if desired. The permissible contact clearance of these precision bearings is ·001 to ·003 in.

In cases where the crankpins have worn oval it is advisable to have them reground, undersize bearings being obtainable from the works.

Engine-sump capacity, 1936 1½-litre Jaguar—9 pints.
Engine-sump capacity, 1937 1½-litre Jaguar—14 pints.
Engine-sump capacity, 1938/9 1½-litre Jaguar—14 pints.
Engine-sump capacity, 2½- and 3½-litre models—20 pints.

Timing Chain, etc.

On all models except 100, the engine has to be lifted slightly at the front end to allow removal of the timing cover. To do so, it is necessary only to disconnect the front engine bearers and the stabiliser arm on the nearside rear of the engine. After removing radiator, water pump, crank dog nut, and pulley and timing cover, the chain is accessible for replacement, and there is no need to disturb the valve timing if the camshaft wheel is taken off, marking it beforehand to ensure its being refitted in the

same position. If, however, the timing should be upset it will be obtained by lining-up the scribe marks on the crankshaft and camshaft wheels. Valve timings are as follows :

Six-cylinder models :

Inlet valve opens 16° before t.d.c. and closes 60° after b.d.c. Exhaust valve opens 60° before b.d.c. and closes 16° after t.d.c.

All 1½-litre models :

Inlet valve opens 10° before t.d.c. and closes 50° after b.d.c. Exhaust valve opens 50° before b.d.c. and closes 10° after t.d.c.

When reassembling it is most important to make sure that the crank pulley is centralised in the timing cover. This is best done by refitting the cover with holding nuts finger tight, and then spinning the pulley on the crankshaft taper (minus key). If it binds, a tap on the timing cover either way will immediately correct its position, when the nuts may be fully tightened, the pulley fitted up with key and dog nut, etc., assembled.

Overhauling Tappets

The camshaft tappets are accessible by taking off the crankcase side plate running alongside the camshaft. The tappet blocks complete with tappets are removable by taking out the attachment bolts, when the tappets or blocks may be renewed as necessary. It will be noted that the centre tappet block is secured by two longer bolts, under the heads of which is held the bracket locating the skew gear for the oil-pump drive shaft. It is very important that these bolts are put back in the same position, as if used elsewhere they will protrude into the cylinder barrels and damage the pistons.

Oil Filter

On all recent models the engines are provided with an external Tecalemit oil filter attached by adapter to the nearside of the crankcase. The filter element should be taken out and cleaned by rinsing in petrol every two or three thousand miles, and should be renewed every ten thousand miles. In refitting the filter body after attending to the element, care should be taken in making an oil-tight joint, and in seating the rim of the body inside the flange of the top portion, to prevent distortion and possible fracture. The filter element should always be renewed when any new bearings have been fitted.

CLUTCH AND GEARBOX OVERHAUL

Dismantling Clutch

In dismantling the clutch for overhaul the operation is similar on all models, the procedure being as follows :

(1) Remove gearbox tunnel, toe boards, and floorboards.

(2) Take off gearbox remote control.

(3) Disconnect prop shaft, front flange, and rear gearbox rubber mounting.

(4) Disconnect nearside engine stabiliser arm by taking out main attachment bolt.

(5) Raise engine as high as possible by jacking up under rear of crankcase.

(6) Take out bell housing attachment bolts and withdraw gearbox unit complete.

The clutch assembly is then immediately accessible and the cover plate assembly is detached from the flywheel after withdrawing the setscrews surrounding the edge of the cover plate.

Clutch Unit

Clutch cover plates and lined plates require specialised servicing and it is inadvisable to attempt relining the former or adjusting the latter without special equipment. The works provide service facilities for clutch units and plates, and replacement assemblies may be obtained and an allowance given on the old parts.

The thrust on withdrawal is taken by a carbon ring which very rarely becomes worn under high mileages unless accelerated by seizure of the linkage or maladjustment. The clutch-operating linkage as used on early 1936 models may tend to buckle when worn and thus lose effective movement. For such cases a modified linkage is obtainable on application to the works.

In overhauling the clutch for "spin" it is always advisable to make sure that the operating fork on the withdrawal shaft is perfectly secure, also, of course, its locking bolt.

In every case it is important to make sure that the linkage works freely without binding, and when finally adjusting to leave a minimum of ½ in. free movement in the top travel of the pedal.

There are otherwise no possible external adjustments to the clutch, but as wear on the carbon ring occurs, the free travel becomes greater and must therefore be taken up as necessary, especially where there is a tendency for the clutch to spin.

Removing Engine Unit

This operation is carried out on quite orthodox lines after taking off the headlamps, bonnet, radiator, floor and toe boards, and all usual connections. The engine stabiliser on the nearside rear should be disconnected by taking out the bolt holding the arm to the rubber block. It is immaterial whether the engine complete with gearbox as one unit is lifted out or whether the engine is separated from the box at the bell housing, although by this latter method there is usually a little difficulty in re-engaging the gearbox primary shaft when re-assembling.

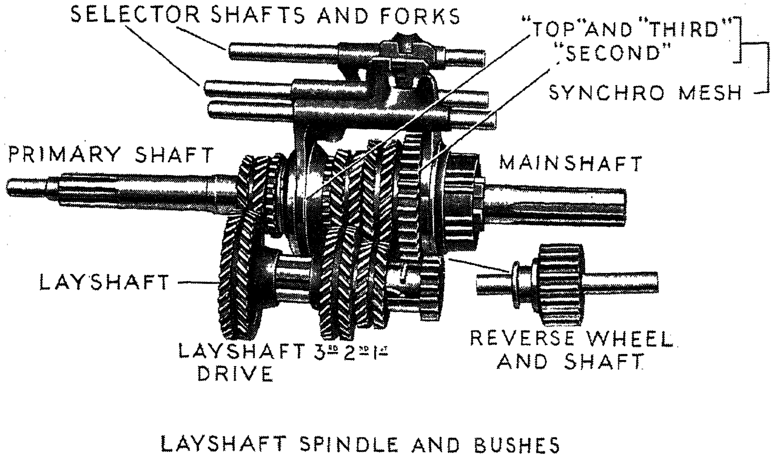


Fig. 3.—GEARBOX ASSEMBLY

Main Line Bearings

On all models prior to 1938 new crankshaft main line bearings require a little hand-scraping and bedding-in to give a good close fit, no contact clearance being necessary. End float is taken on the rear bearing, ·006 in. being allowed. Later models have precision steel-backed bearings which must not be scraped, the contact clearance allowed being between ·001 and ·003 in. If the crankshaft journals are worn they should be reground and undersized bearings fitted, bearings to suit being obtainable from the works in a wide range of sizes.

Camshaft Bushes

These bushes are machined in the cylinder block casting, and the generally recognised maximum contact clearance is ·004 in. Very little wear occurs except after very high mileages, when loss of oil pressure may be attributed to wear in these bushes. The factory have facilities for sleeving with steel bushes on economical terms. Camshaft bearing and float should be set to ·006 in.

Oil Pump

It is very seldom that the oil-pump gears become worn, as they are oil submerged and protected by a surrounding gauze. Unless the gears become scored, due to foreign matter in the oil, any loss of pressure in the pump is probably due to end float between the gears and pump body, it merely being necessary to reface the latter.

Gearbox

In undertaking a gearbox overhaul, the unit must first be removed from the chassis as previously described. To dismantle, the primary-shaft and main-shaft assemblies are withdrawn by removing front end cover, rear driving flange, and complete rear housing. To release the counter body and the gears mounted thereon the layshaft is withdrawn after removing the locking plate, which is bolted to the side of the case.

In fitting any new gears it is always advisable to renew in pairs, to avoid noise and allow for changes in tooth angle.

Countershaft gears should be a free sliding fit on the counter-body, and if new gears are being fitted a little treatment with emery on the splines is sometimes necessary to obtain a satisfactory fit. The layshaft bushes are fully floating, and counter-body end float if excessive may be taken out by the insertion of a bronze thrust washer.

The mainshaft gear assembly is retained by circlip and the mainshaft spigot carried either by bush or by needle roller bearing. Mainshaft end float is taken by a thrust pad on the mainshaft spigot, and care should always be taken to replace this thrust pad and also in its right position, that is, the tapered end facing the primary shaft. Adjust mainshaft end float to approx. ·006 in. by the thrust pad and end cover packings.

To overhaul for synchro it is necessary to see that the sliding dog engagement members, that is, top and third outer synchro sleeve, and first mainshaft gear offer fairly strong resistance when an attempt is made to move them towards the engaging side. To increase this resistance the springs, if weak, should be replaced, and, if necessary, packing shims may be fitted beneath the springs. To further increase synchro action the engaging cone surfaces may be ground in, using oil and grinding paste.

This operation is best performed by holding the mainshaft in the vice, mounting on the shaft the two members to be so treated. Dealing with third synchro first, the third gear is fitted on the shaft with the third and top synchro sleeve complete. A little grinding paste is smeared on the cones and the two worked in together until an even contact surface is formed. The grinding paste must, of course, be thoroughly cleaned off afterwards. Grinding-in the top synchro cones is done similarly, the primary shaft being placed on the mainshaft spigot for this purpose.

Reassembly of the gearbox is the reverse procedure of dismantling, but it is very important to ensure that the second and third countershaft gears are fully meshed with those on the mainshaft, as it is easily possible for these double helical gears to fall into half-mesh. After roughly dropping the mainshaft assembly into position a check can be made by looking down the groove between the two sets of teeth, which should, of course, line up with the gear below. A further check may if necessary be made by sliding a small mirror down the side of the gearbox shell. The selector action can, if necessary, be stiffened up by tightening downwards the selector plunger adjustment to be found on the rear end of the control unit.

SERVICING LANCHESTER CARS

ENGINE, FLUID FLYWHEEL, AND GEARBOX

By A. SQUILLARIO

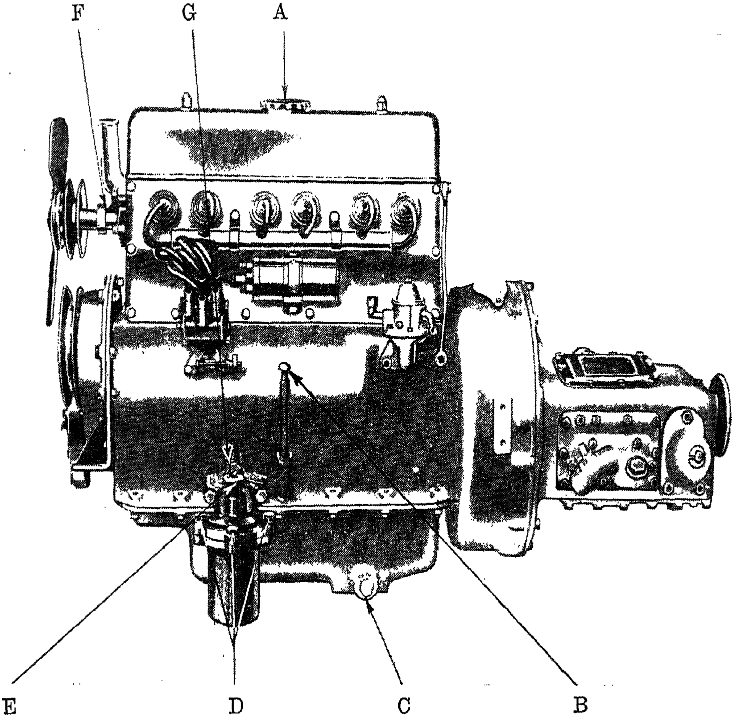


Fig. 1.—View of n/s of Lanchester 14-h.p. roadrider engine

A, Engine Oil Filler Cap. B, Engine Dip Stick. C, Engine Oil Drain Plug. D, Oil Filter Securing Screws. E, Oil Switch. F, Fan Oil Filler Plug. G. Oil Pressure Relief Valve.

14-H.P. ROADRIDER

THE cylinder head and block are cast in one, and to decarbonise and grind in valves it is necessary to remove the cylinder block. The special tools required are shown in Fig. 2. No. 1 is the hook which is attached to the top of the cylinder block (as in Fig. 3). This enables the block to be lifted by means of a chain evenly and progressively until clear of the pistons. Care must be taken not to allow the pistons to fall against the side of the crankcase when released.

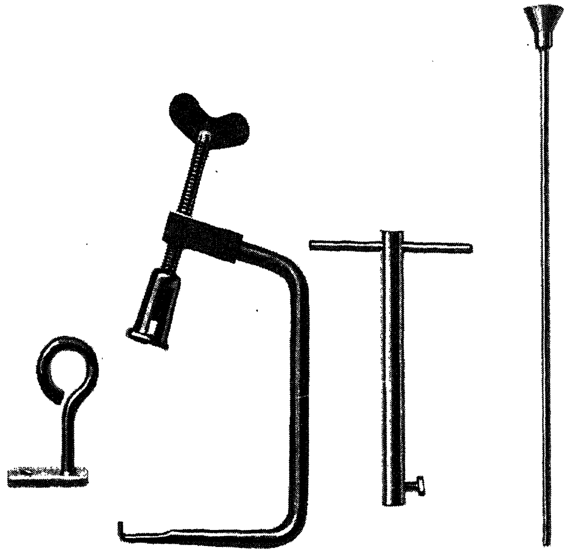


Fig. 2.—SPECIAL TOOLS FOR DECARBONISING LANCHESTER 14-H.P. ROADRIDER

The reverse procedure is followed when assembling. To fit block, turn engine until Nos. 3 and 4 pistons are at top dead centre, and wedge in position by means of a piece of wood pushed into trap in fluid-flywheel housing. Lower cylinder block slowly and carefully until Nos. 3 and 4 pistons begin to enter cylinder bore. The lowest part of the cylinder bore has a long and gradual taper, which allows the piston rings after entry into wide end of taper to be compressed by lowering cylinder block, and enter cylinder bore proper, without aid of clips or special jigs. Continue to lower block, guiding rings on pistons 3 and 4 into cylinder bore. " Wriggle " block gently to prevent rings being trapped.

No. 2 is the valve-removal tool. This tool is inserted through sparking-plug hole so that the lower end supports underside of valve to be removed (see Fig. 5). The tool is then screwed down in order to compress valve spring and remove cotters.

Nos. 3 and 4 tools are used for valve grinding. No. 4 is used for holding valve whilst passing it up the bore to insert in valve guide. No. 3 is used to hold valve whilst grinding in.

The exhaust-valve seats should be closely examined, and if they are

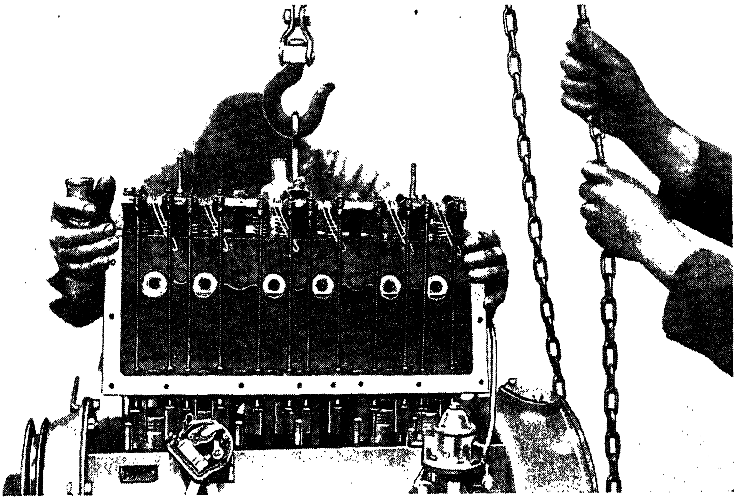


Fig. 3.—SHOWING METHOD OF REMOVING CYLINDER BLOCK, LANCHESTER 14-H.P. ROADRIDER

The cylinder head and block are cast in one, and to decarbonise and grind in valves it is necessary to remove the cylinder block.

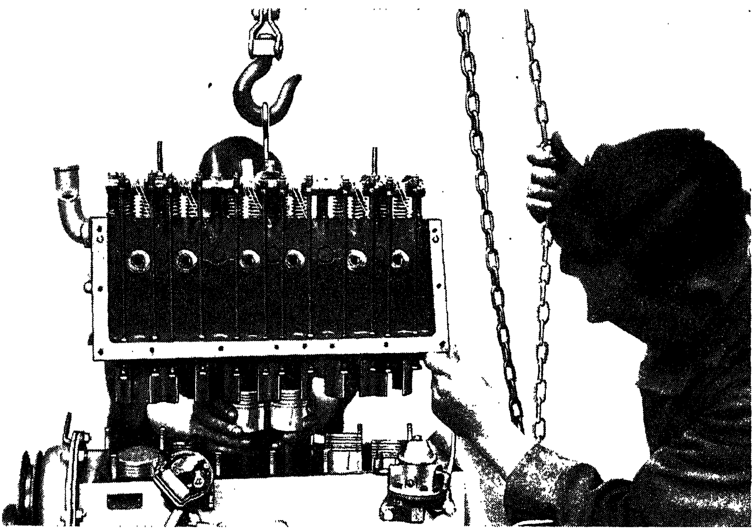


Fig. 4.—REFITTING BLOCK

Entering pistons 3 and 4. Wedge in the pistons at top dead centre by means of a piece of wood pushed into trap in fluid flywheel housing. Note that the lowest part of the cylinder bore has a taper allowing piston rings to enter without aid of special clips.

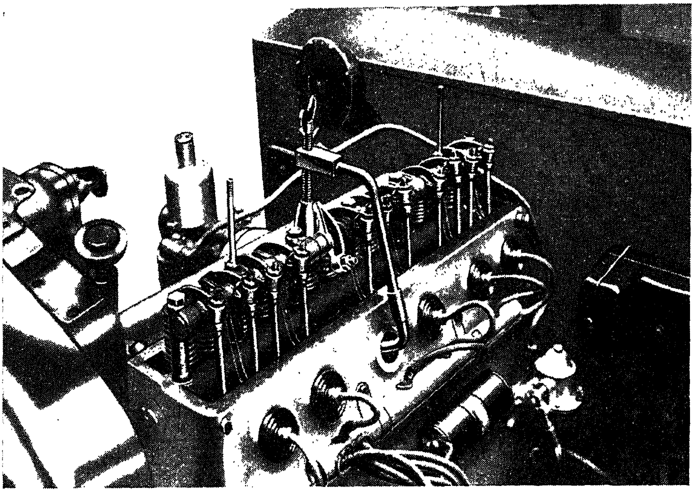


Fig. 5.—TOOL IN POSITION TO REMOVE VALVE COTTERS, 14-H.P. and 18-H.P. ENGINES

badly worn or sunk, the block should be returned to the makers for fitting new valve-seat inserts.

Valve Timing

The valve timing is as follows :

Exhaust valve opens 45° before bottom dead centre.
Exhaust valve closes 5° after top dead centre.
Inlet valve opens on T.D.C.
Inlet valve closes 50° after bottom dead centre.

These figures are obtained with a theoretical tappet clearance of 0·060 in. Desired working clearance is 0·058 in. (when hot).

The flywheel is marked with a line (A) to denote the top dead centre (see Fig. 6).

Ignition Timing

The points should be just breaking 8° before top dead centre (2·3 flywheel teeth) when the automatic advance is in the fully retarded position and manual control on dash in a central position.

Valve and Valve-guide Clearances

If valve guides are worn, new ones should be fitted. The minimum and maximum clearances for valves in valve guides are as follows :

Inlet, 0·0002–0·0016 in.
Exhaust, 0·0002–0·0016 in.

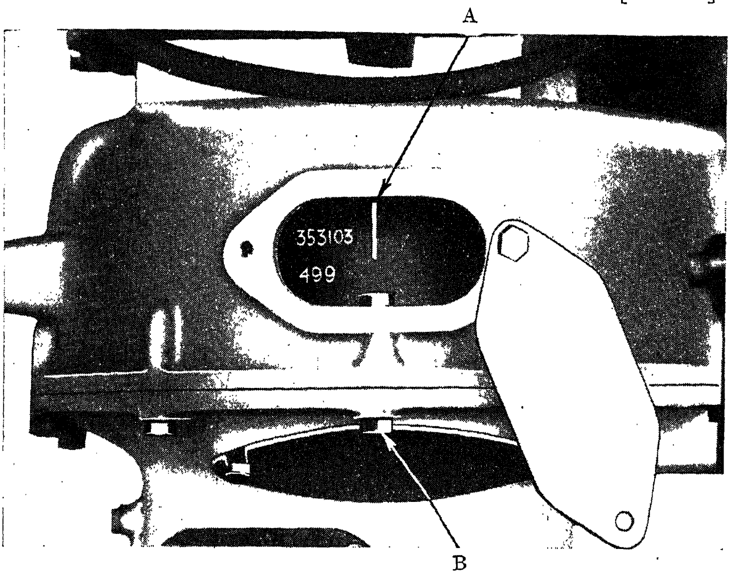


Fig. 6.—PISTON AT TOP DEAD CENTRE WHEN A IS OPPOSITE B, LANCHESTER 14-H.P. ROADRIDER

Whilst giving these limits, it has been found by selective assembly the most satisfactory results are obtained with a clearance of 0·0005 in.

Oil Filter

Whenever the oil filter is removed from the engine and dismantled for cleaning, it is essential that the oil-filter body is filled with oil when reassembling. Failure to attend to this point will result in airlock and consequent damage to engine.

Oil Switch and Green Light

The green light on the dash takes the place of the oil-pressure gauge. When the engine is running the green light should be out, which denotes an adequate pressure of oil. The switch is calibrated to close the contacts and illuminate the green light when the pressure drops below 10 lb. per square inch. The following points should be noted :

Refusal of green light to come on (ignition switch on, engine stationary). Caused by :

(1) Burnt-out bulb.
(2) Broken connection.
(3) Faulty oil switch.

Tests and remedies for the above are :

(1) Fit new bulb.

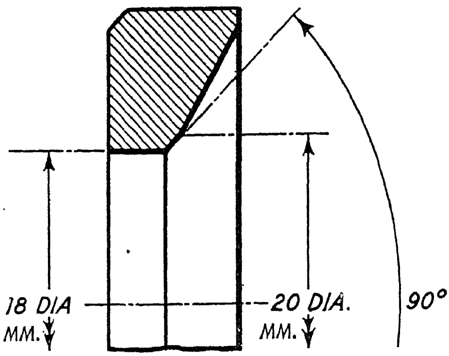


Fig. 7.—METHOD OF CHAMFERING GLAND IN WATER PUMP, LANCHESTER 14-H.P. ROADRIDER

(2) Check all electrical connections, especially terminals on top of oil switch.

(3) Fit new oil switch.

Illumination of green light whilst engine is running (ignore green light flicker when engine is just ticking over):

(1) Insufficient oil in sump.

(2) Failure of oil supply.

(3) Short-circuit in connection from green light to oil switch.

(4) Short-circuit on the underside of the switch caused by deposit of salt water or the like. (This complaint is found mostly on cars overseas.)

(5) Failure of oil switch.

Tests and remedies for the above are:

(1) Top up with oil.

Note.—The level of oil should not be allowed to drop below three-quarters full.

(2) Unscrew plug under oil relief valve and remove spring and valve. Clean and examine carefully. Any foreign matter underneath the valve will cause loss of pressure.

(3) Disconnect wire from terminal on oil switch, and after ensuring that the end is not touching bare metal, switch on ignition. If the green light comes on, there is a short-circuit in the wire from the green light to ignition switch. This wire should be renewed.

(4) Remove the switch, thoroughly clean, and paint with coat of primer and two coats of cellulose.

(5) Fit new switch.

Water Pump

The following adjustment can be made to cure water-pump squeak. Remove the pump and dismantle. The carbon brush or gland should then be chamfered on the inside edge, as shown in Fig. 7. This can be carried out with the aid of a scraper. Do not attempt to remove the gland unless it is desired to fit a new one.

THE 18-H.P. LANCHESTER ENGINE (1935 ONWARDS)

Decarbonising

This model is similar to the 14-h.p. "Roadrider," and it is necessary to remove the block in order to decarbonise and grind in the valves. It is recommended to use the jigs as shown in Fig. 8 for assembling.

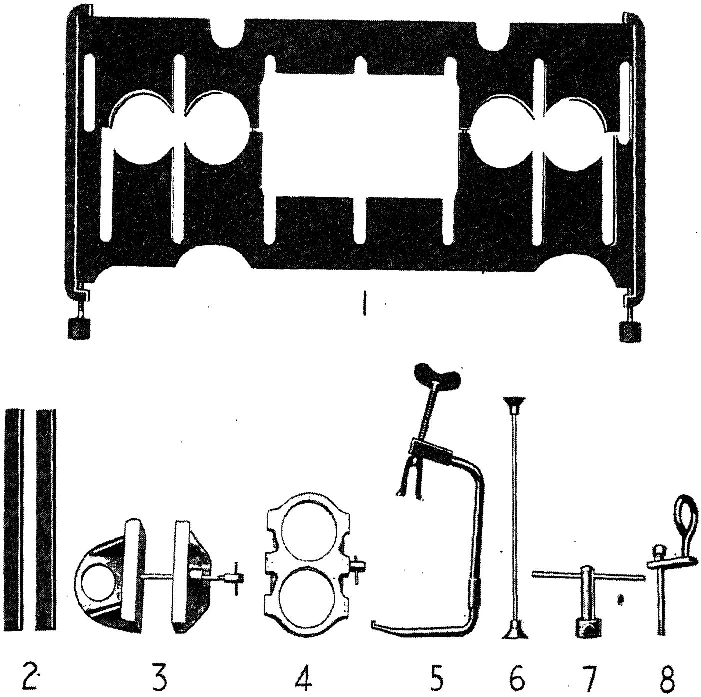


Fig. 8.—18-H.P. LANCHESTER DECARBONISING JIGS

The correct method of assembly is shown in Fig. 9, and is explained as follows :

Turn engine until Nos. 3 and 4 pistons are at the top dead centre, and wedge in position by means of a piece of wood pushed into the trap in fluid-flywheel housing. Place in position jigs Nos. 1, 2, 3, and 4 (see Figs. 8 and 9). Note jigs Nos. 1 and 4 compress the piston rings on pistons Nos. 1, 2, 5, and 6, and pistons Nos. 3 and 4 respectively. Lower cylinder block until pistons Nos. 3 and 4 commence to enter cylinder bores and cylinder block rests lightly on jig No. 4. Remove jig No. 3. Continue to lower block gently and evenly until the rings on pistons Nos. 3 and 4 have entered the cylinder bores. Unscrew and remove jig No. 4 (see Fig. 10). Continue lowering block until it rests on jig No. 1, then remove packing block (jig No. 2), allowing jig No. 1 to be pushed downwards by weight of cylinder block and pistons Nos. 1, 2, 5, and 6 to enter cylinder bores.

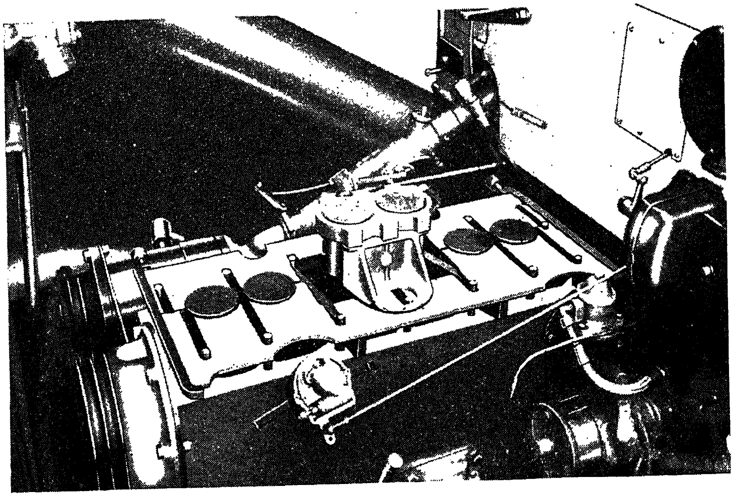


Fig. 9.—18-H.P. LANCHESTER ENGINE
Showing jigs in position for refitting of cylinder block.

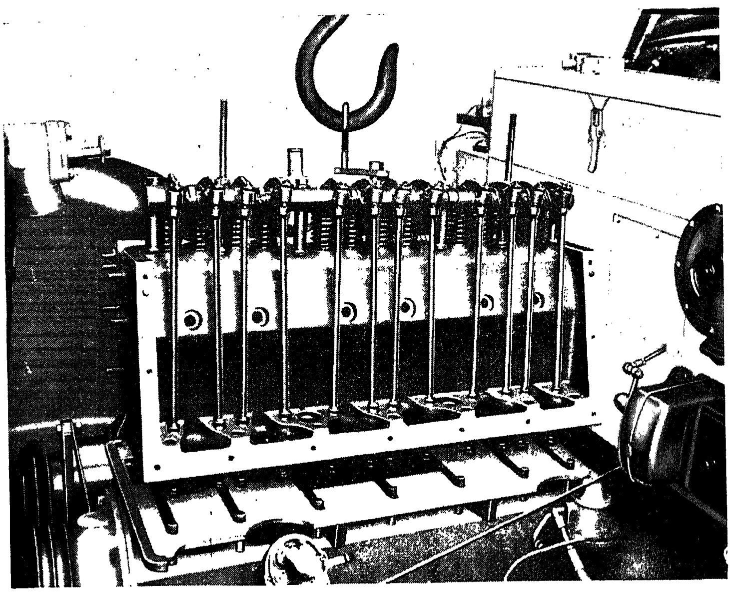


Fig. 10.—REFITTING BLOCK OF 18-H.P. LANCHESTER
Showing block after removing jigs 3 and 4.

When pistons have entered, unscrew and part jig No. 1 and withdraw both halves, rocking cylinder block gently sideways to facilitate this operation. Lower block on to crankcase and screw on holding-down nuts.

THE LANCHESTER TEN AND ELEVEN

The design of this engine is quite orthodox and dismantling is simplicity itself, and it is only necessary, therefore, to mention one or two special points.

A special tool (Fig. 12) is provided to facilitate the removal of the valve springs, either with the head *in situ* or removed. Attach the pillar of the special tool to the nearest cylinder-head bolt, as shown in the illustration, and screw down the butterfly nut on the tool, thus compressing the spring. Release the mouse-trap spring from the valve rocker and push down the rocker in order to uncouple the push-rod. When the cylinder head is removed, it is important to remember to mark each push-rod so that they are all replaced in their correct position. Place the push-

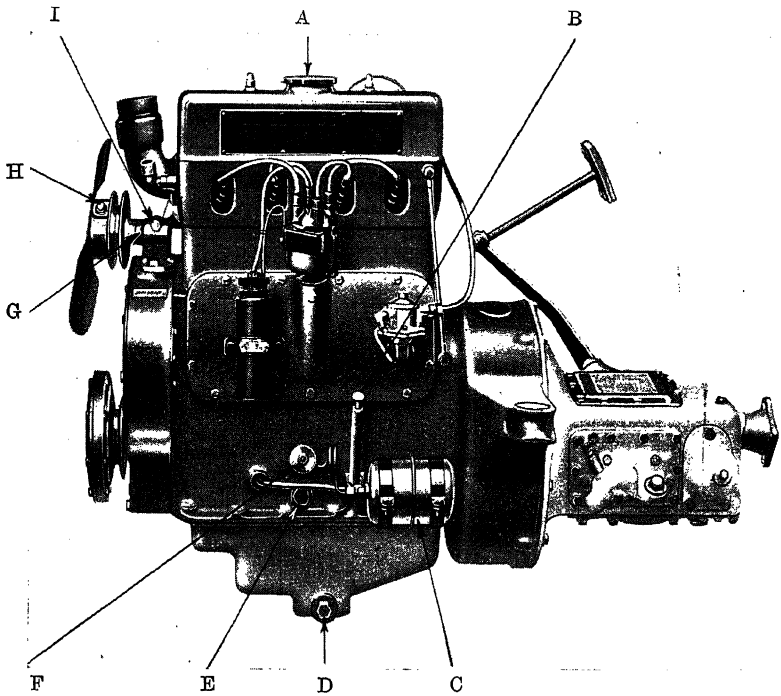


*Fig.*11.—N/S VIEW OF 10-H.P. ENGINE (1933–1936)

A, Engine Oil Filler Cap. B, Engine Dipstick. C, Oil Filter. D, Engine Oil Drain Plug. E, Oil Pressure Relief Valve. F, Oil Switch. G, Hole for Fan Adjustment. H, Fan Oil Filler Plug. I, Fan Pinch Bolt.

rod on one side and swing the rocker back clear of the valve stem.

With the valve spring compressed, remove the valve cotters. The valve cannot fall into the cylinder head, owing to a circlip in the valve stem.

When assembling cylinder head, replace the twelve cylinder-head nuts as in Fig. 13, giving each a half-turn at a time until all are up tight.

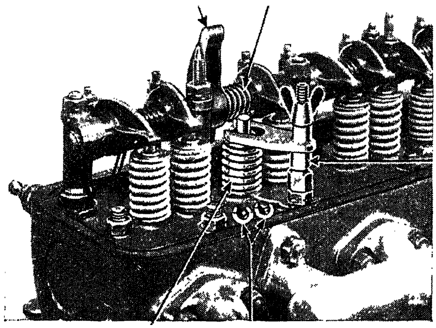


Fig. 12—REMOVING VALVE SPRINGS ON LANCHESTER TEN AND ELEVEN

Adjustment of Camshaft and Dynamo Chain

The chain is adjusted by turning the dynamo in a clockwise direction (looking from the rear). It will be found that there are slots on the dynamo facing, so that by loosening the nuts the dynamo can be turned, thus tightening the chain. To renew the chain, the chaincase front cover can be removed completely, and on the back of the chaincase on the offside of the engine will be found a small cover, which can be removed to enable the spring link to be detached.

Valve Timing

The valve timing is as follows :

Inlet valve opens on top dead centre.
Inlet valve closes on 50° after bottom dead centre.
Exhaust valve opens on 45° before bottom dead centre.
Exhaust valve closes on 5° after top dead centre.

The best individual tappet clearances are marked on the valve cover, and should be strictly adhered to.

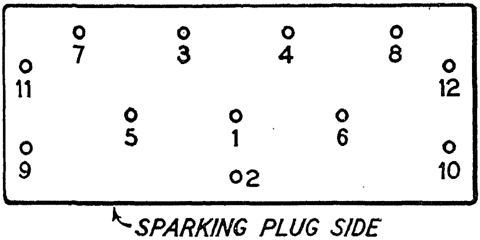


Fig. 13.—INDICATING THE SEQUENCE IN WHICH THE CYLINDER HEAD NUTS SHOULD BE TIGHTENED (LANCHESTER TEN AND ELEVEN)

Ignition Timing

Spark occurs 10° before top dead centre, with the automatic advance in the fully retarded position.

Lubrication

The length of the life of the engine between over-

hauls depends to a great extent on using the correct brand of oil, draining and refilling regularly and keeping the sump filled to the top mark on the dipstick. It is of paramount importance not to allow the level of oil to fall below three-quarters full. The oil filter is of the non-cleanable type and should be renewed regularly at the mileage recommended by the makers. The filter is arranged in such a way that it is not in the direct delivery circuit from the pump to the bearings, but in a parallel circuit together with the oil relief valve and the oil switch. It is possible, therefore, for the oil filter to be entirely choked without affecting the supply of oil to the bearings.

In common with all Lanchester cars, no oil gauge is fitted, but an oil switch is used in conjunction with a green-light indicator on the dash to warn drivers of loss of oil pressure.

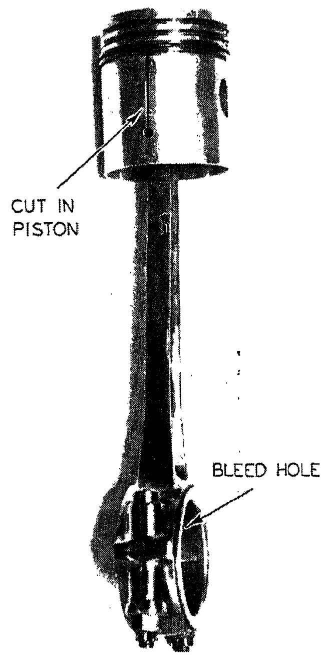


Fig. 14.—CORRECT POSITION OF PISTON

The bleed hole in big-end bearing of connecting rod should be on opposite side to split in piston.

Fitting Piston on Connecting Rod

It will be noticed that the skirts of all Lanchester pistons are split. The split should always be opposite the bleed hole in the connecting-rod bearing, and when fitted in bore should rest on the thrust side, i.e. the camshaft side of the engine. Fig. 14 illustrates correct method of fitting.

LANCHESTER 14-H.P. DE LUXE

This model is fitted with detachable cylinder head and conforms to the 10-h.p. model for simplicity in dismantling and assembling. Figs. 15 and 16 show sectional views of the engine.

Fan and Water Pump

It should be noted that load should not be applied through the ball races, otherwise indentation of the races by the balls may result, with consequent noise in the running.

Valve Timing

Inlet opens 18° before top dead centre.
Inlet closes 50° after bottom dead centre.
Exhaust opens 50° before bottom dead centre.
Exhaust closes 50° after top dead centre.

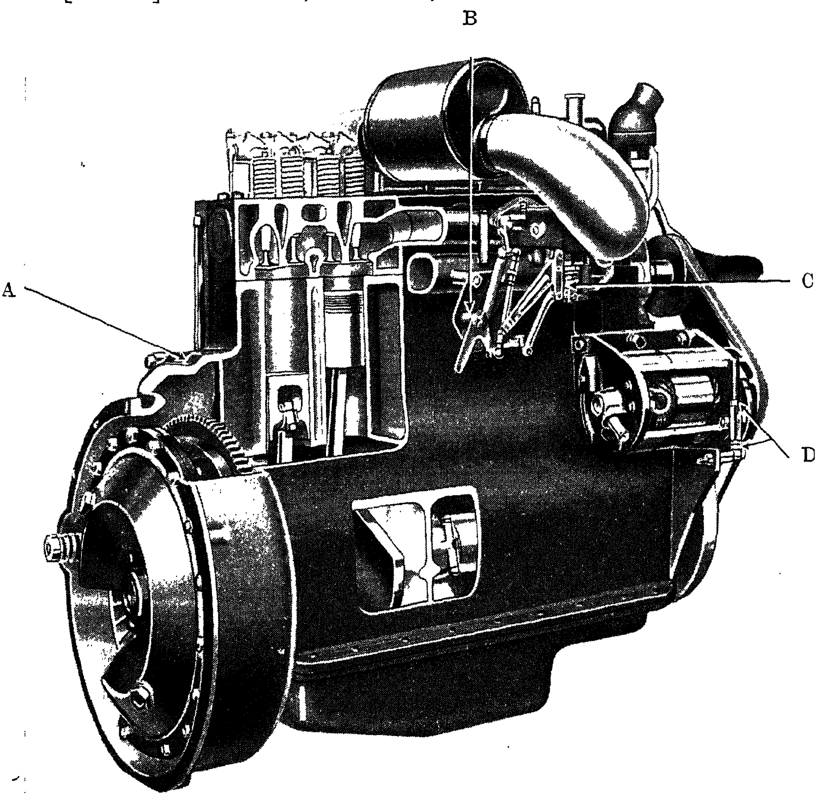


Fig. 15.—Sectional offside view of 14-h.p. de luxe engine

A, TDC mark on Crankcase. B, Oil Hole for Throttle Lever. C, Jet Adjusting Nut. D, Fan Belt Adjusting Nuts.

To set timing, turn engine by hand until No. 1 piston is at the top of its compression stroke. The flywheel is marked "TDC," and this should be in line with point A on crankcase (Fig. 15).

Turn the camshaft chain wheel until the locating hole coincides with the hole in the crankcase (see Fig. 17) and insert a bolt to hold in position. The chain can now be fitted.

Ignition Timing

The spark occurs 6° before top dead centre, with the automatic advance in the fully retarded position and the manual control in mid position.

The 6° is found $\frac{5}{8}$ in. before the TDC mark on the flywheel (on the self-changing gearbox model) and $\frac{11}{16}$ in. before the TDC mark (on the synchromesh gearbox model).

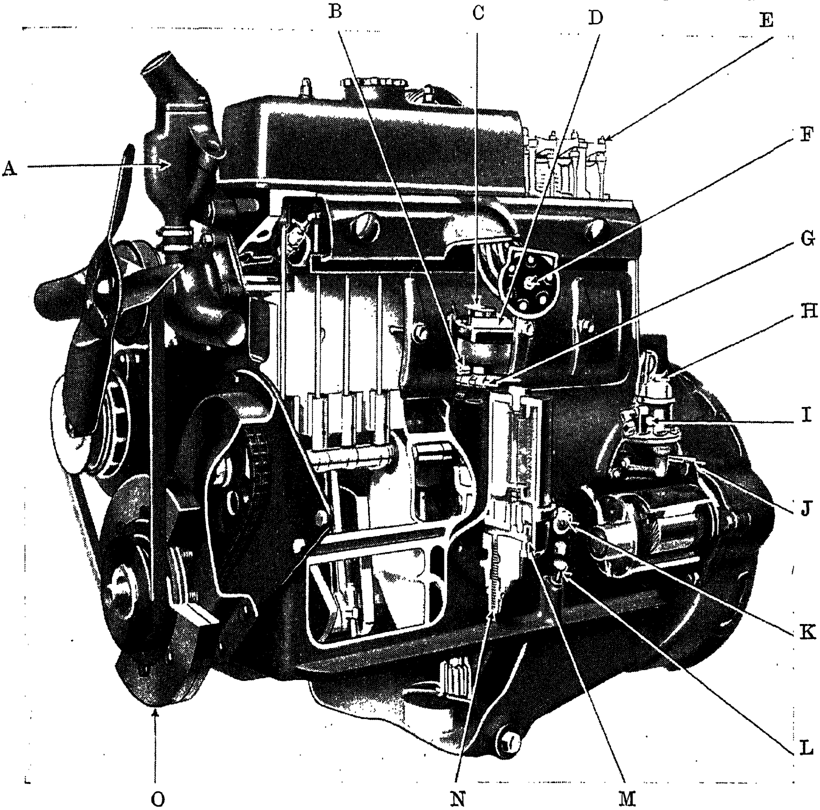


Fig. 16.—SECTIONAL VIEW OF NEARSIDE 14-H.P. DE LUXE ENGINE

A, Water Thermostat. B, Distributor Greaser. C, Distributor Arm. D, Condenser. E, Tappet Adjuster Nut. F, Carbon Brush. G, Distributor Pinch Bolt. H, Pump Cover Setscrew. I, Petrol Pump Drain Screw. J, Petrol Priming Lever. K, Oil Switch. L, Engine Sump Dipstick. M, Bypass Valve. N, Oil Relief Valve. O, Crankshaft Vibration Damper.

LANCHESTER "LIGHT 6" 12 h.p.

The engine is of similar design to the 14-h.p. "Roadrider," having an integral head and cylinder block. Special tools required for decarbonising and grinding in valves are similar in principle to those shown in Fig. 8.

Dismantling Instructions

Drain water (tap at bottom of radiator), remove bonnet and off-side radiator stay rod. Remove fume extractor from valve cover, and cover complete. Remove all carburettor controls by pulling of ball joints, and remove air silencer. Disconnect petrol pipe between pump and carburettor, and remove fan oiler plug and top elbow water pipe from cylinder block.

Twist rocker springs to bear against push rods. Pull off high-tension cables from plugs, unscrew protecting covers and remove plugs. Lift off distributor cover, remove the securing bolts on tappet cover and draw cover off.

Disconnect exhaust pipe from manifold, and slacken off adjustment and bracket nuts on dynamo, press dynamo towards engine and slip fan felt off pulley.

Remove oil feed pipe to rear of rocker shaft. The water connection between cylinder block and pump is a push fit and can be pulled out.

Disconnect thermometer pipe from rear of cylinder block. Remove the cylinder holding-down nuts, and raise cylinder block evenly and progressively by means of block and tackle and special tool No. 8 (Fig. 8).

When pistons are out of the bores care should be taken not to allow them to strike against the side of the crankcase.

Grinding in Valves

Remove valves with the aid of special tool No. 5 (Fig. 8), which is inserted through sparking-plug hole so that lower end supports the underside of the valve (see Fig. 5).

Insert valve head in special tool No. 6, pass up cylinder bore and push through valve guide. Attach special tool No. 7 to valve stem and tighten up clamping screw. Remove valve-holder tool No. 6 and grind in valve.

To replace valves after grinding in proceed as follows: Place valve head in special tool No. 6, pass up cylinder bore and through guide, attach circlips, and remove tool. Proceed as above with adjacent valve.

Insert special tool into plug hole, so that the end of the tool engages with the valve heads within the cylinder head and holds them up. Replace springs and cotters with the aid of special compression tool.

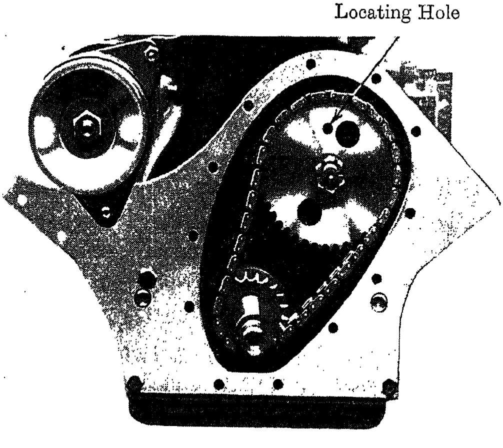


Fig. 17.—VALVE TIMING, 14-H.P. DE LUXE
Locating hole coincides with hole in crankcase.

To Replace Cylinder Block

Paint bottom of surface of cylinder block with jointing compound. Set crankshaft so that pistons No. 3

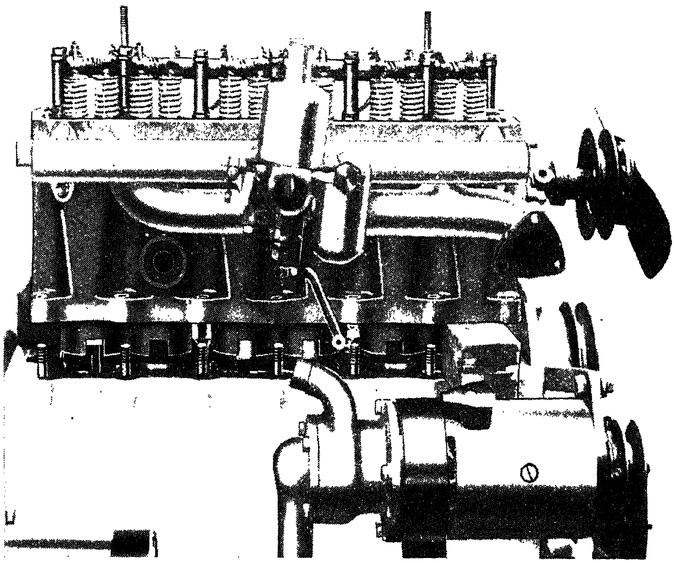


Fig. 18.—CYLINDER BLOCK IN HALF-RAISED POSITION

and No. 4 are at top dead centre. Attach special piston-ring compressor tool to pistons 3 and 4. Place in position jig (Fig. 19) to compress rings on pistons Nos. 1, 2, 5, and 6, packing up from crankcase on special blocks as shown in Fig. 19. Lower block evenly and slowly on to pistons Nos. 3 and 4.

When the pistons have entered the bores the cylinder block will push the piston-ring compressor tool downwards and when rings are in the cylinders this may be removed.

Continue lowering block until it rests on the jig, when packing blocks may be removed, allowing the jig to be pushed downwards by the cylinder block, and the pistons to enter their respective bores.

The block now rests on the jig, and by a slight sideways movement of the cylinder block each half of the jig may be withdrawn and the block fully lowered into position.

To assemble remainder of engine reverse dismantling proceedings.

Ignition Timing

To reset ignition timing remove the valve cover, and set No. 1 piston at top dead centre by turning the flywheel until the mark on it is at its highest position (see Fig. 20). Set the distributor points to ·012-in. feeler gauge and set point to be breaking on No. 1 lead. The firing order is 1·5·3·6·2·4.

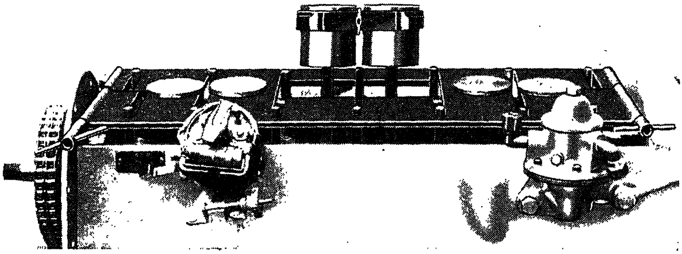


Fig. 19.—View of crankcase with jigs in position for lowering the cylinder block

Lanchester "Light 6" 12 h.p.

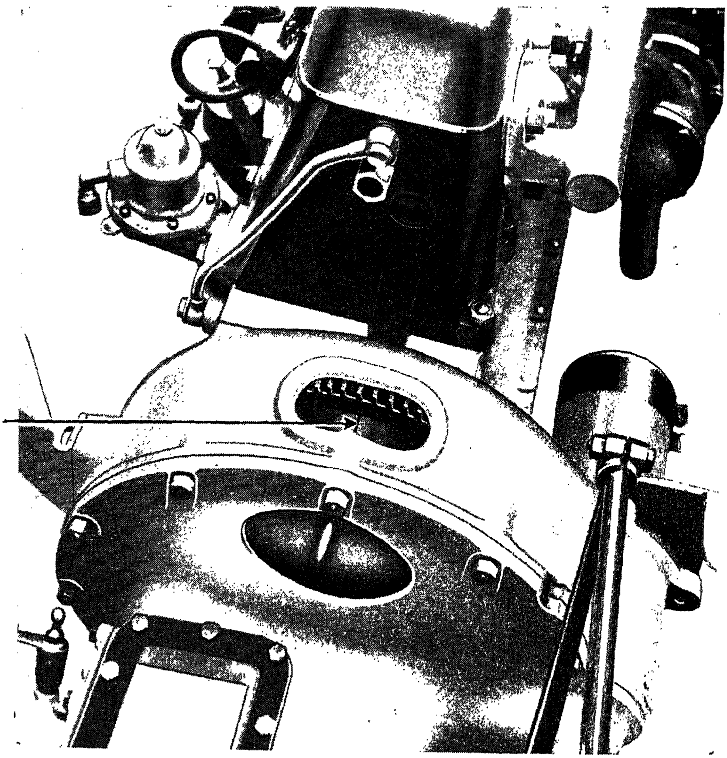


Fig. 20.—Position of flywheel mark (A) when No. 1 piston is at top dead centre

"Light 6" 12 h.p.

The micrometer adjustment permits finer adjustment to be made after the distributor has been fitted.

Valve Timing

Inlet valve opens	Top dead centre.
,, ,, closes	50° after bottom dead centre.
Exhaust ,, opens	45° before bottom dead centre.
,, ,, closes	5° after top dead centre.

Best individual valve-tip clearance given on valve cover.

To Renew Timing Chain

It is necessary to remove radiator, starting-handle dog, fan belt, camshaft pulley wheel, and crankshaft vibration damper. Remove bolts holding timing-case cover and draw off. Remove chain by extracting connecting spring link.

Set No. 1 piston at top dead centre by turning the flywheel until the mark is at the top (see Fig. 20).

Turn camshaft sprocket until the pointed stud on its back face coincides with the pointed stud attached to the crankcase (see Fig. 21). Fit new chain and replace timing cover, taking care not to tighten up securing bolts until it is certain that the pulley and starting dog, together with the oil-return sleeve behind it, are rotating freely. Tighten case down evenly.

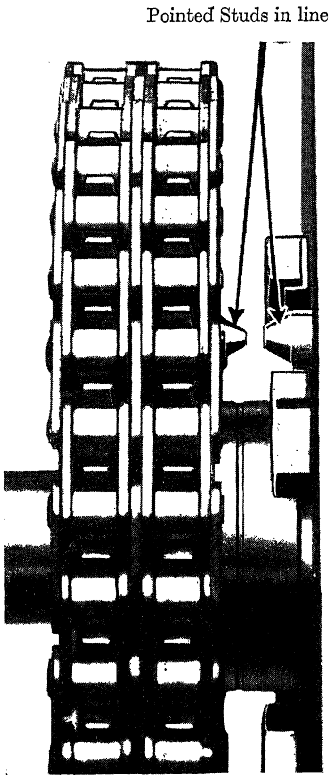


Fig. 21.—VALVE TIMING "LIGHT 6" 12 H.P.

With No. 1 piston at T.D.C. (see mark on flywheel), pointed stud on camshaft sprocket should be in line with similar stud on crankcase.

LANCHESTER 15/18 (1932/3/4 Models)

The early type 18-h.p. Lanchester was fitted with detachable cylinder head, and decarbonising is carried out without the use of any special tools, except for one to remove valve springs.

Ignition Timing

To reset the timing, turn the engine until No. 1 piston is at the top of the compression stroke, and at the point the mark on the flywheel

will be at the top. Turn the engine clockwise (looking from the rear) until the mark on the flywheel is 6 in. past top dead centre. At this point the contact-breaker points should be just breaking for No. 1 cylinder with the hand ignition lever fully advanced and the distributor arm held against the governor spring in its fully advanced position.

If the distributor is withdrawn from its casing and the engine is not disturbed then the distributor cannot be replaced incorrectly owing to the off-set pin on the distributor drive.

Valve Timing

The valve timing can be set very easily; on the nearside of the engine at the rear will be found a cover plate over the timing wheels. The cover plate should be removed, also the sparking plug from No. 1 cylinder.

Turn the engine until No. 1 piston is at the top of the stroke. Turn the camshaft until the peg on the camshaft chain wheel is in line with the peg on the crankcase and attach chain.

Clean the face of the cover and apply jointing compound before replacing.

Valve timing:

Inlet opens	16° after top dead centre.
,, closes	36° after bottom dead centre.
Exhaust opens	60° before bottom dead centre.
,, closes	8° after top dead centre.

THE FLUID FLYWHEEL

The fluid flywheel, as fitted to Lanchester cars, resembles externally an ordinary enclosed plate clutch, but actually consists of two parts only, one of which is the flywheel or driving member and the other the driven member. The driven shaft runs upon a bearing within the flywheel casing; there is in addition a gland packing to prevent oil leakage. The various types of gland packings are shown in Figs. 22–24.

To replace Packing (Lanchester 15/18)

In the event of leakage, the inner oil-retaining ring should be replaced. Fig. 22 shows the parts completely dismantled. In order to carry out this operation, first drain the flywheel. After removing universal coupling, undo the bolts holding the rear cover plate in position and remove cover plate.

Withdraw the bearing retaining plate. The oil-retaining ring situated within this plate need not be removed, as it is unlikely that this needs replacing.

Withdraw the bearing housing, complete with bearing. Remove the oil-retaining spring, cover, and inner oil-retaining ring. After replacing the inner retaining ring, assemble in the opposite order, making sure that the rear cover-plate bolts are tight. A good-quality liquid packing should be used between the bearing housing and flywheel casing, also

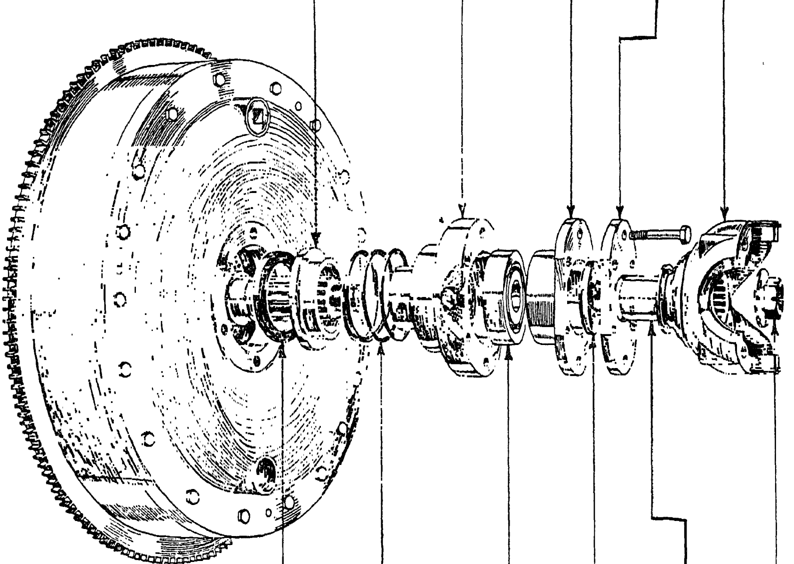


Fig. 22.—Type of fluid flywheel used on Lanchester 15/18 h.p.

between the bearing retaining plate and cover plate. Finally, lubricate the flywheel bearing with grease-gun, and refill flywheel with engine oil.

To replace Gland Packings on Flywheels shown in Figs. 23 and 24.

In order to replace the gland packing, it is necessary to remove the gearbox first. Undo the three nuts holding the retaining ring and withdraw in turn the gland packing spring (where fitted), gland packing cover, distance piece, and packings.

Always examine copper washer on the plug, and replace if damaged. If both plugs are removed, always replace in the same hole, otherwise balance of flywheel may be upset.

THE FOUR-SPEED SYNCHROMESH GEARBOX AS FITTED TO LANCHESTER 14-H.P. DE LUXE

The method of dismantling and assembling is as follows :

(1) Remove top cover whilst second gear is engaged.

(2) Disengage second speed and engage first speed and reverse simultaneously, thus locking the gearbox mainshaft. After taking cotter

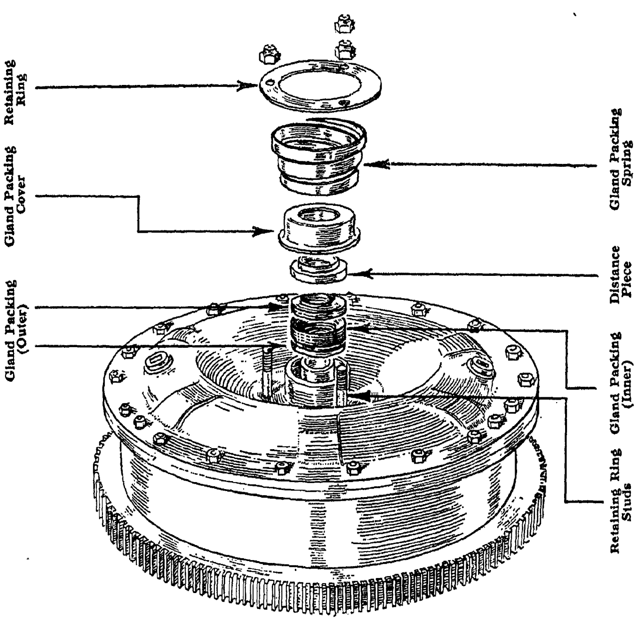


Fig. 23.—TYPE OF FLUID FLYWHEEL USED ON—
Lanchester "10" (up to Chassis No. 25999), Lanchester "Light 6," Lanchester "18" (up to Chassis No. 12841).

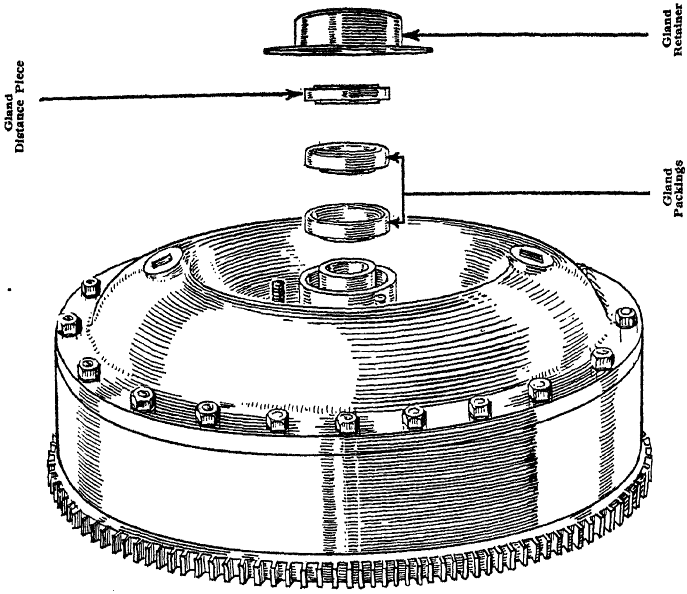


Fig. 24.—TYPE OF FLUID FLYWHEEL USED ON—
Lanchester "10" (from Chassis No. 28000), Lanchester "14," Lanchester "18" (from Chassis No. 12842).

from castellated nut on flange end of mainshaft, nut can be unfastened in an anti-clockwise direction.

(3) The gears should be returned to neutral position.

(4) Mainshaft flange can readily be removed from shaft, after which speedometer drive housing can be taken off by removing from nuts.

(5) The five nuts which hold the gearbox extension to the gearbox shell should now be removed, as well as the bolt and the locking plate which holds the reverse shaft and layshaft.

(6) The gearbox extension is withdrawn with the aid of a suitable extractor, which also removes the ball race and speedometer driving wheel.

(7) Cut the locking wire holding the front end cover bolts, removing bolts and cover. Care should be taken not to damage the oil seal.

(8) Take out the layshaft to allow layshaft gears to rest on the bottom of the box.

(9) Remove front and rear races with the aid of an extractor.

(10) Holding the mainshaft assembly clear of layshaft, move the large constant-mesh gear on the layshaft towards the centre of the box, so that the driving dogs of the primary shaft are clear.

(11) The primary shaft can now be removed and the needle rollers (190ff) can be allowed to fall into the box. Care should be taken not to lose the thrust button and ring inside the bearing recess.

(12) Remove the mainshaft assembly complete through the top of the box.

(13) Layshaft and reverse gear can now be taken out.

(14) To remove the gears from mainshaft, take off the third-speed synchro sleeve which slides on spline.

(15) Remove the circlip which is located in a groove immediately in front of the third-speed gear.

(16) The gears and thrust washers will now slide off the mainshaft.

The Synchromesh Units

These should not be interfered with unnecessarily; but to strip, push the outer sleeve over the inner sleeve, when the six springs and balls will be exposed. When reassembling, the same springs should be replaced in their respective units, as they are selected to give an arranged load.

The Change-speed Tower

(1) After removing locking wire, take out the three square tapered shank pins which hold the change-speed forks in position.

(2) Take the long cotter out of the three adjusting pins on top of the tower and remove the three plungers and springs.

(3) Hold the first-speed fork in the selector rod out of the tower.

(4) Remove the top-speed and reverse forks in the same way as in (3).

(5) Take out the swinging fork by first bending back the locking washer and undoing the fulcrum-pin unit on the offside of the tower.

(6) Now the fulcrum pin itself can be unscrewed out of the tower, leaving the swinging fork and its spring free for removal.

(7) The final operation is to remove the change-speed lever, which is effected by first applying pressure to each side of the spring retainer in a downward and backward direction, so that the slot in the retainer will pass the lever just above the shoulder on which it locates.

(8) Lever can be removed after taking out its fulcrum pin situated just under the dome cover.

Reassembly of Box and Control Tower

The box can be reassembled by a reversal of the stripping operation, particular notice being given to the following points :

(1) See that the thrust washers on the mainshaft are assembled with oil grooves nearest the bushes.

(2) The needle rollers on the mainshaft assembly should be fitted with the aid of a little vaseline after the mainshaft is back in the box.

(3) After the primary shaft is assembled on the mainshaft, and before the races (main) are replaced, care must be taken to see that all three pairs of constant-mesh gears are in line with each other.

(4) When reassembling the control tower, adjust the swinging fork so that it does not foul the sides of the change-speed fork, when all are in neutral position. Square-headed pins in the change-speed forks must be tight on their tapes.

The Borg & Beck Clutch on 14-h.p. de Luxe Lanchester fitted with Synchromesh Gearbox

Periodically the amount of free movement in the pedal should be checked. This should be 1 in., which corresponds to a clearance of not less than $\frac{7}{16}$ in. at the release bearing. If the pedal requires adjustment, turn the pedal stop (fixed to chassis frame) a fraction of a turn in an anti-clockwise direction until free movement of 1 in. is obtained on the pedal and tighten locknut.

THE SELF-CHANGING GEARBOX

The only adjustment that should be necessary on the self-changing gearbox concerns the toggle action which controls the adjustment of the brakes. More toggle action is required when there is a tendency for the gears to slip. Remove cover from the top of the gearbox, and before commencing adjustment, set the selector lever to the gear that is about to be adjusted, and make a mark on the brake-adjusting nut with an indelible pencil. Push the gear-engaging pedal up and down a number of times until the pencil park on the brake-adjusting nut has ceased to revolve.

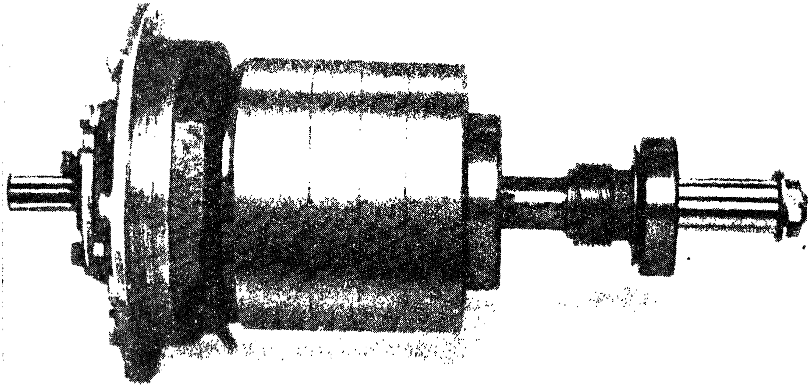


Fig. 25.—THE RUNNING GEAR OF SELF-CHANGING GEARBOX

Presuming the adjusting nut remains stationary, see that there is freedom of travel on the busbar-operating lever, as shown in Fig. 29.

If the gear still slips after the above adjustment, toggle action can be further increased. Select the gear to be adjusted and push gear pedal up and down several times. Lift off the automatic adjuster spring eye and loop from their pillars, and change into any other gear (except neutral).

Using the special tool (see Fig. 30), unscrew the automatic adjuster nut about one turn, and replace the automatic adjuster spring. Next slacken the locknut on the brake-adjuster stop and screw in the brake-adjuster stop one half-turn and lock up. Select the gear which is being reset and move gear pedal up and down again. The brake-adjuster nut will be found to stop moving before reaching its original position. If on test sufficient improvement is not observed (i.e. gear is still slipping), the process may be repeated to give still more toggle action.

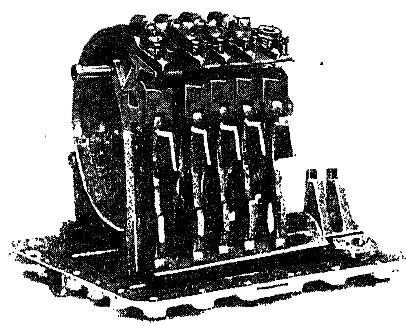


Fig. 26.—THE SELECTOR MECHANISM OF SELF-CHANGING GEARBOX

The "Over-centre" Position

There is a limit to the possible increase in toggle

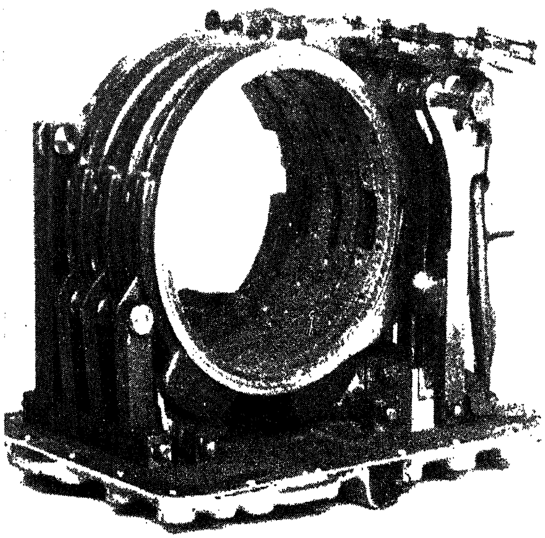


Fig. 27.—THE BRAKE GEAR

action, due to the brake pull-rod and pivotal point of the table eventually coming in line with the toggle-link fulcrum. When this point is reached, any further lengthening of the brake pull-rod (due to unscrewing of the brake-adjuster nut) will result in the gear coming "over centre."

The "over-centre" position makes a very convenient datum from which to work when resetting gears, and the amount of toggle action given to a gear can be accurately described in terms of "the number of turns after which the adjuster nut ceases moving when pumped up from the 'over-centre' position." The fewer the number of turns from the "over-centre" position, the greater is the amount of toggle action.

General Rules for setting Toggle Action after Dismantling

The torque reactions exerted by the brake bands are greater in the case of first and reverse gears, and in consequence it is necessary to give these a greater amount of toggle action. Average settings for the various gears are as follows :

Reverse gear, $\frac{1}{4}$ turn from "over-centre" position.
First gear, $\frac{1}{4}$ turn from "over-centre" position.
Second gear, $\frac{3}{4}$ turn from "over-centre" position.
Third gear, 2 turns from "over-centre" position.
Top gear (cone clutch), $\frac{1}{4}$ turn from "over-centre" position.
Top gear (plate clutch), 3 turns from "over-centre" position.

It should be noted that the plate-clutch type top gear requires very little toggle action ; and only sufficient to allow a positive drive, with a small reserve against slip, should be given. At the same time, care must be taken that toggle action is not reduced to an amount which provides

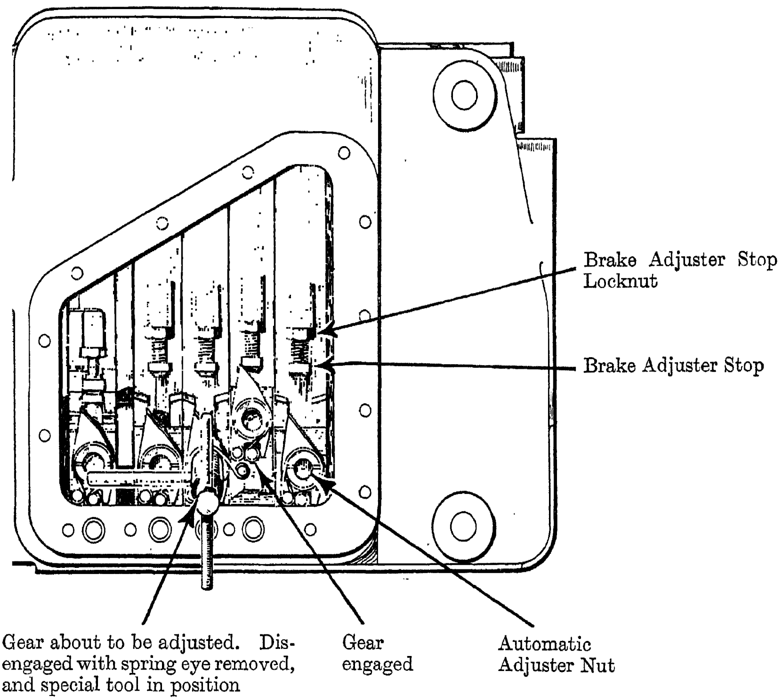


Fig. 28.—ADJUSTMENT FOR SLIPPING GEAR

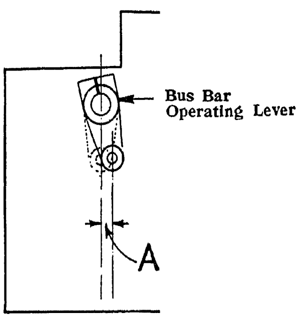


Fig. 29.—SEE THAT THERE IS FREEDOM OF TRAVEL ON THE BUSBAR OPERATING LEVER

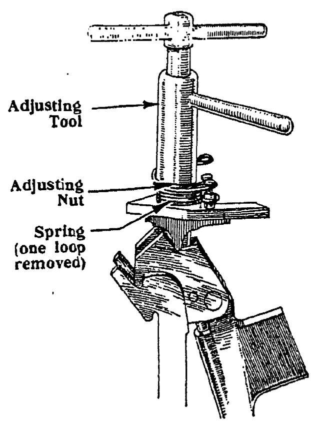


Fig. 30.—ILLUSTRATING USE OF SPECIAL ADJUSTER TOOL

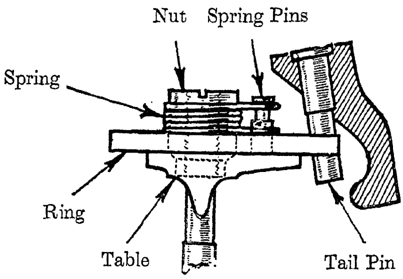


Fig. 31.—THE AUTOMATIC BRAKE ADJUSTMENT

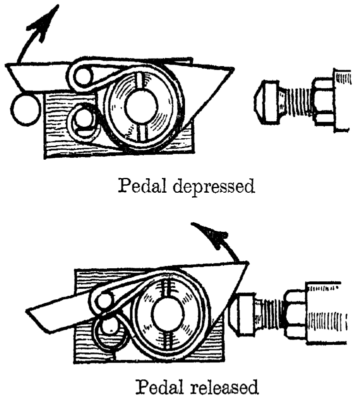


Fig. 32.—THE WORKING OF THE AUTOMATIC BRAKE ADJUSTER

a travel of less than $\frac{1}{10}$ in. for the clutch front plate, otherwise drag will occur in neutral.

On the latest type of plate-clutch top gear, the adjustment on top gear is fixed by means of a collar fitted behind the adjuster stop, and on no account should this be touched.

Dismantling the Gearbox

The dismantling of the gearbox may be dealt with in two sections :

(1) To remove the running gear.

(2) To remove the gear casing and dismantle the brake gear.

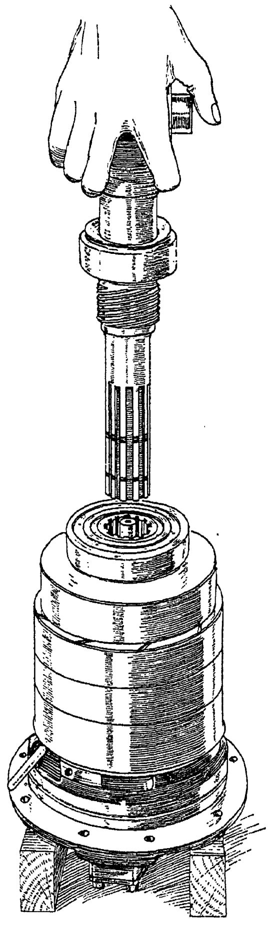
To remove the Running Gear

First, remove oil drain plug and drain out all oil. Then remove selector cover from nearside of box and remove actuating spring cap and undo the adjusting screw to release the tension on the spring.

Note.—Take special notice in which of the three holes on the spring adjusting screws is the locking wire, and on reassembly tighten the adjusting nut so that the wire may be replaced in the same hole, or take special notice of the distance the spring-adjusting screw projects from the cover, and on reassembly tighten the screw so that it projects the same distance. Withdraw the actuating spring, spring guides, and buckets complete. Remove the speedometer pinion and casing, also coupling flange from the rear end of the box and the rear end cover plate.

Next, remove the top gear automatic adjuster nut. This has the effect of releasing the operating strut for top gear. Break the joint of the front cover for about $\frac{1}{4}$ in. by tapping gently. Tap the rear shaft at the rear end towards the front end.

Taking great care to keep the rear shaft, etc., complete with the brake drums, push the running gear from the rear end, steadying it with a tube on the rear shaft to prevent it fouling. Care should be taken to see that the fourth gear strut does not foul the end plate. On withdrawing the running gear, stand it vertically on end so that the various parts may be lifted in the correct order and so facilitate re-erection (see Fig. 33). Two small holes are provided at the rear end for removal of the large ball-race.



. 33.—DISMANTLING RUNNING GEAR

Examining for Wear

When the whole assembly has been dismantled, it should be washed off in petrol and careful inspection made. All ball-races should be examined for wear. Examine distance washers and make certain drums do not touch. Examine gears, especially planet wheels and their races, also see rivets in the carrier are tight.

There should not be any play in the selector ball joints and gear-engaging pedal links, otherwise difficulty will be experienced in selection of gears due to insufficient movement in the box.

Before assembling, all parts should be immersed in clean engine oil.

Replacing Eccentric

If eccentric is removed from driving shaft, make sure when replacing that the hole in eccentric coincides with hole in shaft, otherwise oil pump will not operate.

To remove and replace Gear Casing and dismantle the Brake Gear

Remove the setscrew securing the top gear hooks. When replacing do not forget the distance washer between the hooks. Turn the gearbox on its side and remove the nuts securing the bottom cover and lift the case over the brake gear.

To dismantle the Brake Bands

Remove the automatic adjuster spring, adjuster nut, ring, and table. Lift out the thrust pad and strut as one unit. Press down on top of the

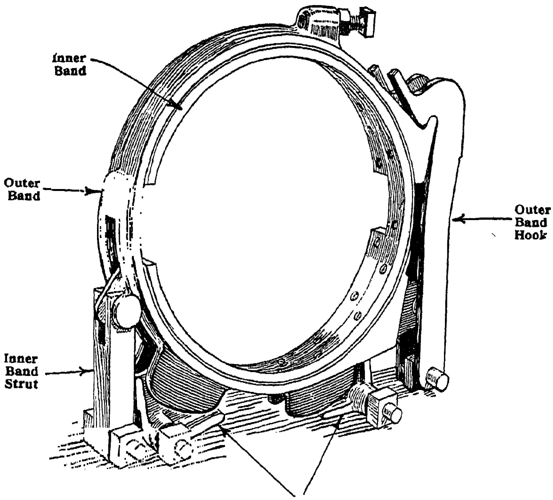


Fig. 34.—REASSEMBLING GEARBOX

brake band and disengage the two hooks which take in the lug on the brake band, then pull the brake band to one side. Take out the split pin and joint pin on the brake strut and centralisers, taking great care not to lose the centraliser guide springs. If new brake linings are required, it is essential to fit them with the greatest accuracy. This can only be done with the use of special assembly tools. It is recommended, therefore, that the worn bands be returned to the makers for relining, and thus maximum efficiency will be obtained from the gearbox.

Reassembling the Gearbox

The process of removing the brake bands is reversed, and care must be taken to see that the centraliser springs are not omitted. Assemble the reverse band first. Place the band in position and enter the offside centraliser spring and pin. Engage the brake hooks and enter the rearside centraliser spring and pin.

The reverse band will now be in its running position. Connect up the pin with the internal brake-band link in the vertical position. Assemble thrust pad, automatic adjuster table, ring, and nut.

On completing the assembly of the brake bands, see that the top-gear pull-rod is in its position. Do not forget to replace the busbar. Secure the top gear hooks with the setscrew and distance piece. Apply jointing and fit bottom cover, securing with nuts.

To replace Running Gear

Before inserting the running gear, take great care that the brake-band liners are well in line. A block of wood turned to the appropriate size and pushed through first will assist in this way. Put jointing on the front cover and insert running gear from the front of box, being careful not to break the assembly.

On no account must it be pulled through from the rear end. See

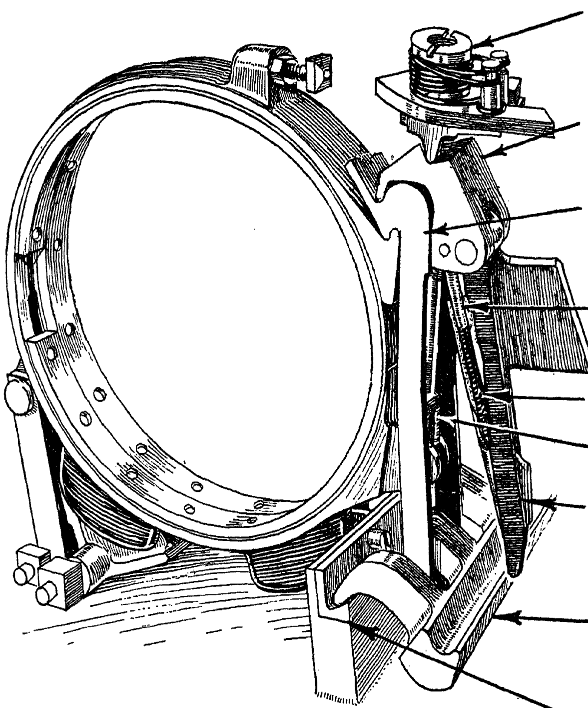


Fig. 35.—REASSEMBLING SELF-CHANGING GEARBOX

that the cap and pull-rod for the fourth gear are in position, otherwise it will jam the running gear. Secure the front end cover with nuts and spring washers. Hook the top-gear strut into the cup at the bottom of the pull-rod and replace the top-gear strut, table, and nut. Put jointing on the rear end cover and fit.

To replace the Actuation Spring

Replace the actuation-spring bucket, noting that the bucket is correctly assembled. Replace the two members in the actuating spring, taking care that the bottom pivot is in the centre of the bucket. Replace the spring cover and screw down the spring until the locking wire can be placed in the same hole or same position from which it was taken when box was dismantled. Replace the adjusting-screw cover and cam gear. Connect up speedometer drive. Move pedal up and down by means of a bar attached to the gear-engaging lever, and adjust toggle action as described previously. Refill with oil, and fit bar to engine, taking care that it is in correct alignment with the fluid flywheel.

SPECIAL POINTS TO BE WATCHED WHEN REPAIRING ALVIS CARS

THE ENGINE, CLUTCH, AND GEARBOX

By F. C. BROWN

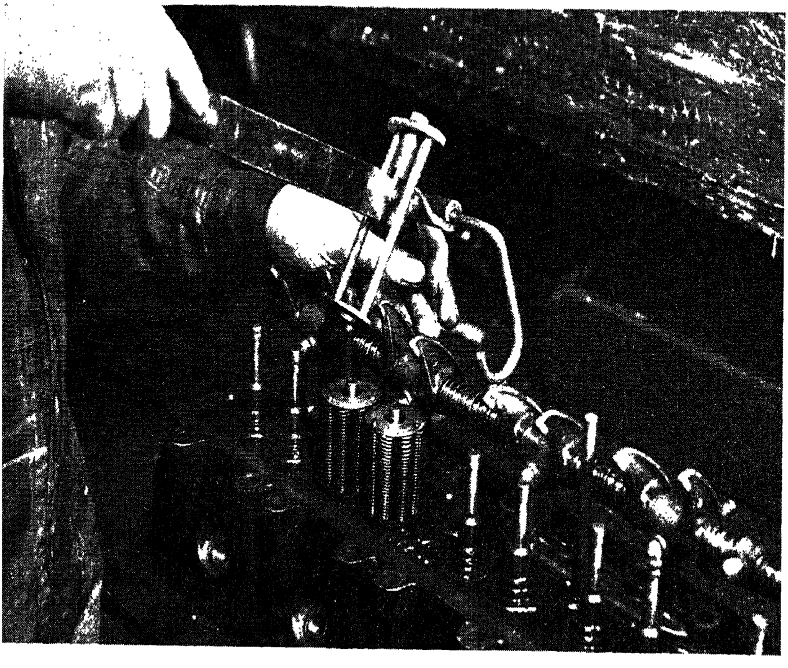


Fig. 1.—VALVE REMOVAL
Cluster valve spring compressor being mounted on rocker shaft.

IN compiling the following notes it has been assumed that the reader is conversant with general automobile repair work; the particular operations mentioned, or items detailed, having been selected because, to those not well acquainted with Alvis design, difficulties might arise in dealing with those operations. Where not otherwise stated ordinary procedure is followed; the notes are intended as guidance in respect of those jobs where Alvis design or unusual construction calls for a departure from normal practice.

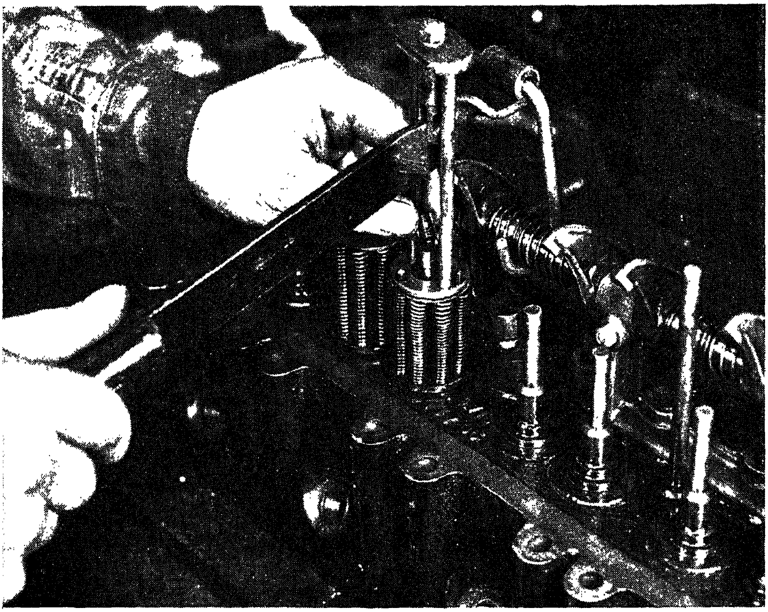


Fig. 2.—VALVE REMOVAL
Valve spring compressor in action.

To make the points perfectly clear it must first be explained that they refer mainly to the more recent models in the Alvis range, i.e. the 4·3-litre, Type H.S. Speed 25, Crested Eagle 25-h.p., 16·95 and 20-h.p. Silver Crest, and the Type II 12/70 four-cylinder model. There is a similarity between the 4·3-litre, Speed 25, and Crested Eagle models, but both the Silver Crest and 12/70 types differ in many respects.

ENGINE

Decarbonising

Although hardly a repair, engine decarbonising is a maintenance operation that the repairer is so often called upon to perform that a few hints on this subject will not be amiss.

Tappet Adjustment

Decarbonisation and valve grinding naturally completely disturb the valve-operating mechanism, and engine troubles can frequently be traced to maltreatment. Cases of burnt valves will almost always be found to be the result of insufficient tappet clearances. Generally speaking, the tappet clearances up to the summer of 1938 were ·006 in.

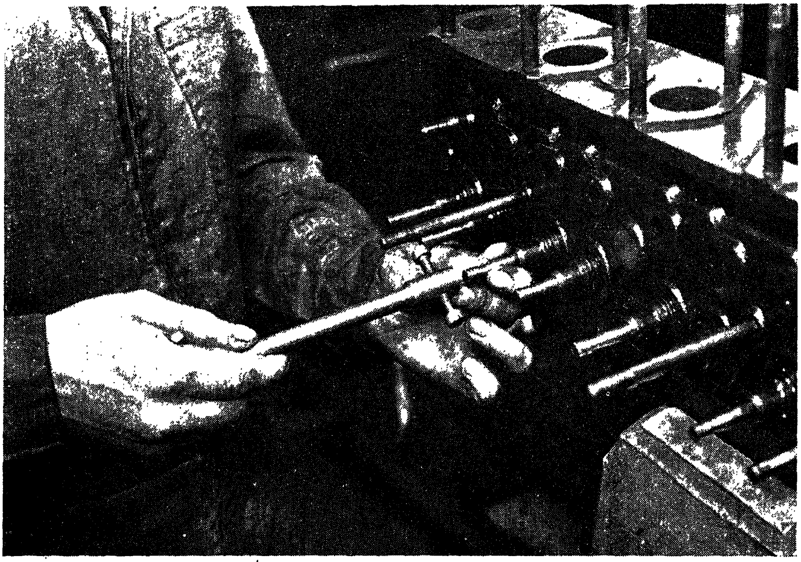


Fig. 3.—VALVE GRINDING
Bolting special valve grinding tool to valve stem.

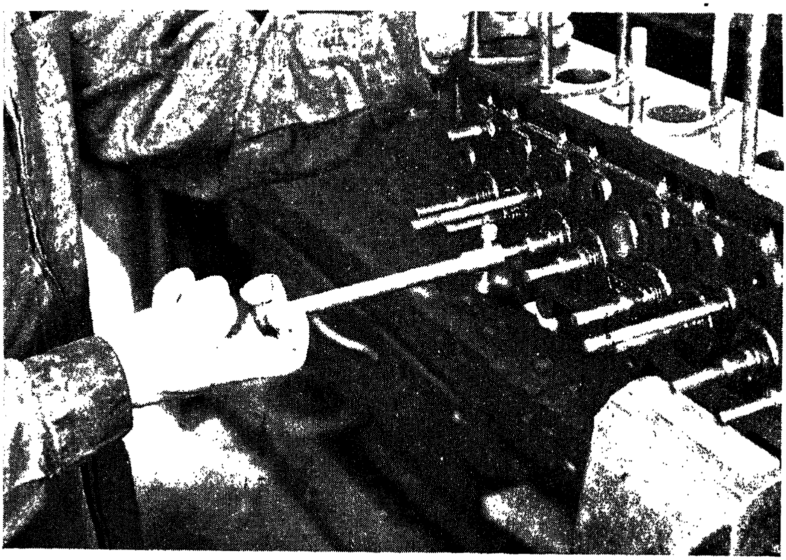


Fig. 4.—VALVE GRINDING
Showing the valve grinding tool in operation.

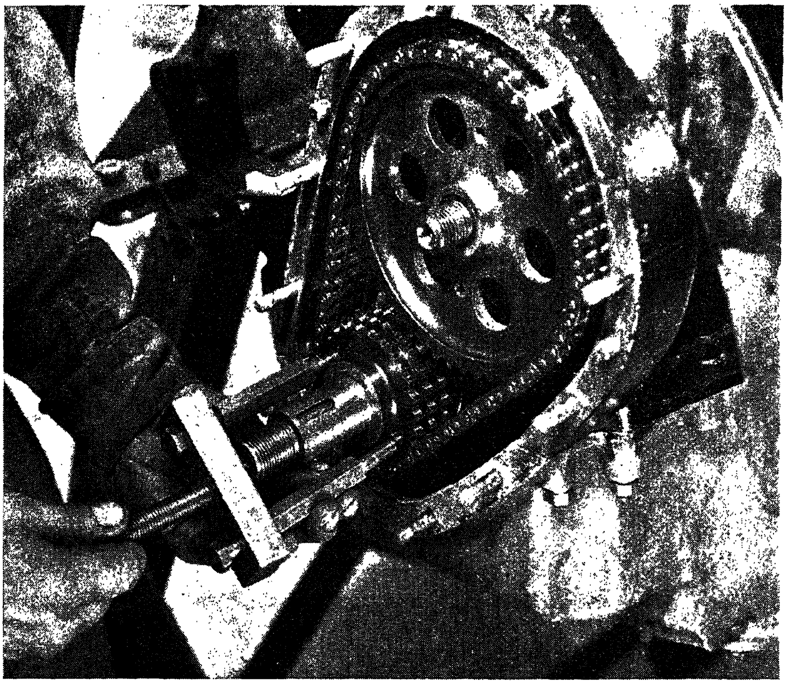


Fig. 5.—REMOVING TIMING GEAR
Mounting crankshaft timing gear extractor (12/70 and Silver Crest).

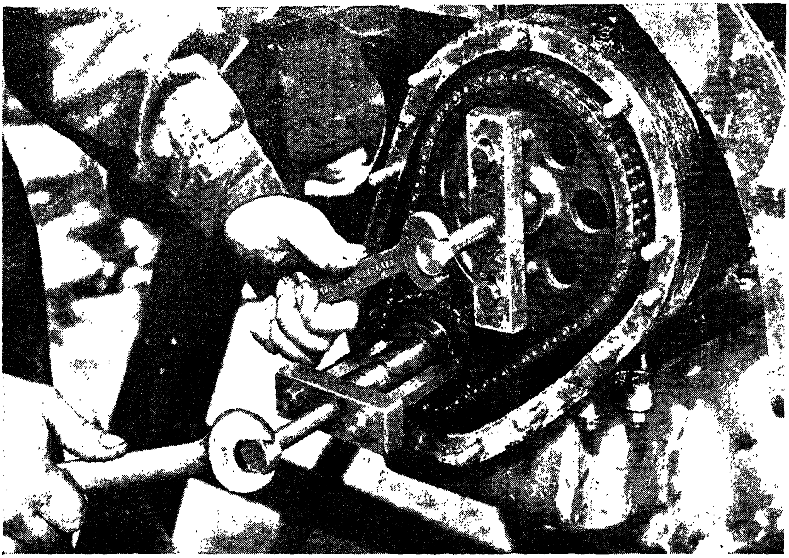
From the summer of 1938 onwards tappet clearances were ·009 in., but reference should be made to an instruction plate attached to the valve cover of every engine in the current range.

Again, it is really important on Alvis engines that a final tappet adjustment be made after decarbonising, or an overhaul when the car has done a few hundred miles. A final check at 1,500 miles is worth while. The clearances given apply to both inlet and exhaust with the engine at running temperature.

Dealing with the Valves

A final word about valves. It should be remembered, after decarbonising, that the valves should be replaced in their proper order, as on most models the inlet and exhaust valves are of different materials, and trouble is likely to be experienced if an inlet valve is fitted to an exhaust seat.

All models, except 12/70, have cluster-type valve springs (nine springs per valve), but special compression tools can be obtained from the works,



ig. 6.—REMOVING TIMING GEAR

Both crankshaft and camshaft timing gears should be withdrawn together as illustrated (12/70 and Silver Crest).

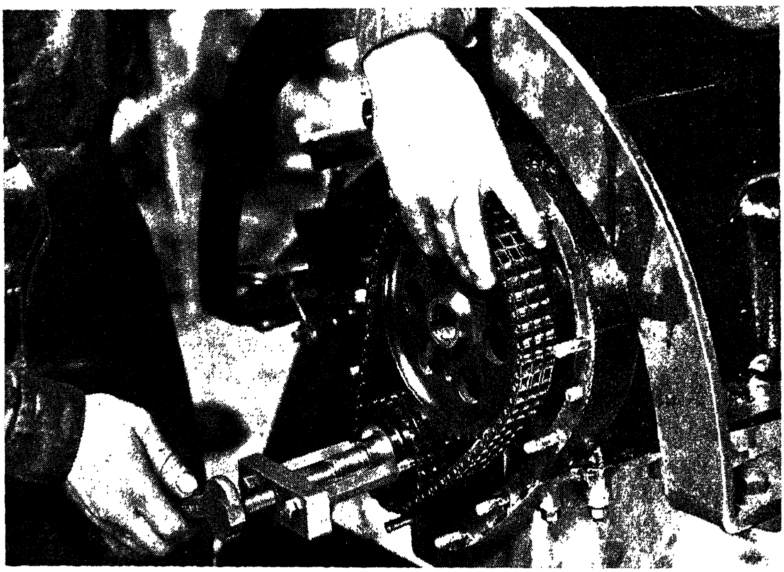


Fig. 7.—THE FINAL STAGE IN REMOVING TIMING GEAR (12/70 AND SILVER CREST)

also for removing push rods. Further, earlier models have tulip valves and when grinding, a tool which will grip the valve stem is necessary. This applies to all types, as none of the valves are slotted.

Replace any doubtful valve springs, even the small ones. The cost of replacements is small, the possible damage from neglect great.

Engine Timing

Chief of the special matters to watch when overhauling the 4·3-litre Type H.S. Speed 25, and Crested Eagle 25-h.p. engines is the removal and replacement of the timing chain, and the timing. As a matter of fact most of the earlier six-cylinder engines need the same careful attention so that no excuse is necessary for detailing the procedure. It must be noted that in cases where the timing gear is situated at the rear of the engine it is not possible to dismantle without first removing the engine from the chassis.

After removing the clutch casing, clutch assembly, and flywheel, the top half of the timing-gear case can be detached, exposing to view the timing-chain sprockets. The 94-pitch endless chain passes in turn round the crankshaft sprocket, the camshaft timing wheel, dynamo-driving wheel, and finally round the automatic spring-controlled chain tensioner.

The automatic chain tensioner comprises a stationary hollow shaft carrying a free wheel. This shaft is bolted on to the main body of the crankcase so that the free-wheel end of the shaft protrudes into the timing case. On to the shaft extension is fitted an eccentric housing, and fitted round this is a dual-toothed sprocket over which passes the timing chain. The outer member of the flywheel is coupled to the housing by means of a dowel peg, the only rotating part of the mechanism being the sprocket, which revolves round the housing. The chain is maintained in correct tension by a spring fitted inside the housing, the inner end being anchored at a slot in the shaft and the outer end over a peg in the housing. It will thus be seen that the tendency of the spring is to push the housing in an upward and inward direction, thus taking up any slack or chain stretch between the crankshaft sprocket and the dynamo-driving wheel. The rachet of the free wheel prevents the tensioner working back in the reverse direction. It is obvious that the chain tensioner works exactly like a normal jockey pulley, but by its ingenious construction it is quite automatic and needs no attention whatever.

Removing and Replacing the Timing Chain

It is quite easy to remove the timing chain provided the correct procedure is followed. Unless the sequence of operation is followed carefully, some difficulty may be experienced in removing or replacing the chain. In the first place, the chain can be removed immediately it has been slackened by putting the tensioner out of action. This is done by removing the split-pin and washer which holds the flat coil spring in

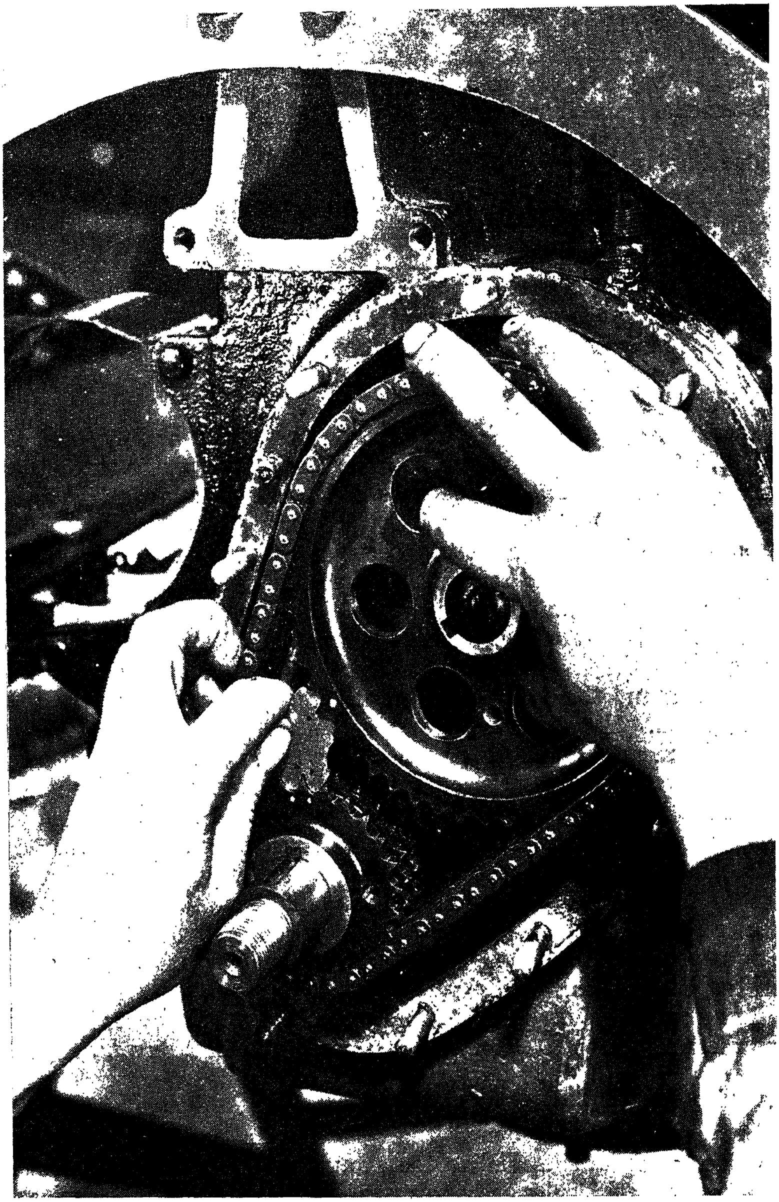


Fig. 8.—ENGINE TIMING
Retiming the engine, using timing gauge. Note dot punch-marks.

position. The spring can then be removed, but care must be taken to prevent it flying out. Next, by sliding the sprocket and housing slightly forward the free-wheel dowel peg will become disengaged and the housing will be free to swing over, thus slackening the chain, which can now be lifted clear of the sprockets.

Before replacing the chain, it is necessary to make sure that the timing is correct. A small timing gauge, consisting of a flat piece of metal shaped to fit between the teeth of the camshaft and crankshaft sprockets, can be found in the tool kit. One of the teeth on the former sprocket is marked with two centre-punch dots, while one of the teeth on the latter sprocket is marked by one dot. The chain wheels can be turned until the curved timing gauge can be slipped between the marked teeth. With the chain-tensioner spring and sprocket removed the chain can then be refitted, first round the camshaft and dynamo shaft driving sprockets. The eccentric housing should be turned to leave the chain as slack as possible.

The chain-tensioner sprocket is next to be fitted. A short length of flexible steel, such as a 6-in. steel rule, is passed in between the chain and the teeth as the sprocket is pushed on to the housing. When the sprocket is sufficiently far on, the rule can be drawn away, leaving the chain registering with the teeth.

The final operation is the refitting of the coil spring. Insert the end of the spring in one of the cross-slots in the shaft, then slip a thin tommy-bar into the eye at the outer extremity of the spring. Now tighten the coil of the spring in a clockwise direction by pulling the eye round about two to two and a half turns before slipping it over the peg provided in the housing. The washer and split-pin may now be replaced, and the job is complete.

Engine Timing on Silver Crest and 12/70 Models

On the Silver Crest and 12/70 models, where the timing gear is at the front, it is not necessary to remove the engine unit, as access to the gear can be gained by removing the radiator and engine front cover. Special extractors are required to remove the crankshaft and camshaft sprockets, which must be removed in unit with the endless driving chain, but the absence of auxiliary drives and a tensioner device simplify the task. The same system of dot punch-marks is used for retiming purposes.

It will be observed that on these models the timing-case cover (which is located on two dowels) is fitted with an oil retainer, and care must be taken when replacing to see that the flange is fitted outwards.

Engine Removal

Points to watch when removing the engine vary according to the model. With the 17- and 20-h.p. Silver Crest it is better to first remove the gearbox. This is accomplished by uncoupling at the propeller-shaft

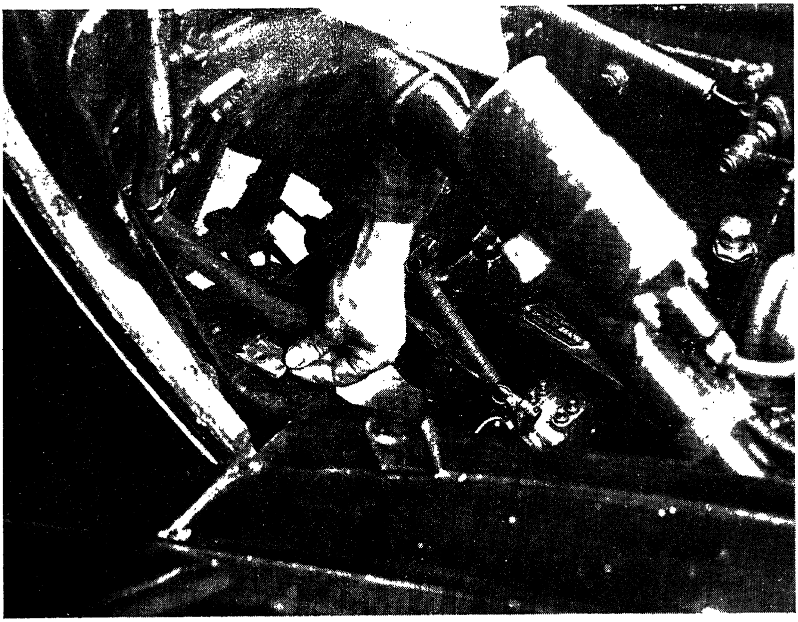


Fig. 9.—ENGINE MOUNTING
Shimming rear mounting of engine to correct weight distribution on Silver Crest engine.

end, next the clutch-casing end, and finally the rear mountings. The latter, it must be noted, represent one of the engine main supports, so that care must be taken to provide some other support for the rear of the engine before removing the bolts.

Before these engines can be slung from the chassis the bridge piece of the front springs (transverse type) will have to be dismantled. This necessitates lowering the front permanent jacks until they just reach the ground, so providing support for the springs and frame when the bridge piece is removed.

In the case of the 12/70 power unit, the complete engine, clutch, and gearbox assembly have to be removed as a whole. Besides the obvious connections, take away first the accelerator, clutch, and brake pedals, not forgetting to remove the front starter dog on the crankshaft. A good suggestion is to use the fan pulley on the crankshaft as a suspension point, for passing a rope around it gives a good grip when lifting the unit. Move the engine forward a little first, then raise the front (fan pulley) end, before finally swinging clear.

The 4·3-litre, Crested Eagle, and Speed 25 cars have a separate gearbox unit ; consequently it can be disconnected at the front flexible coupling of the short clutch shaft. When removing the engine, do not

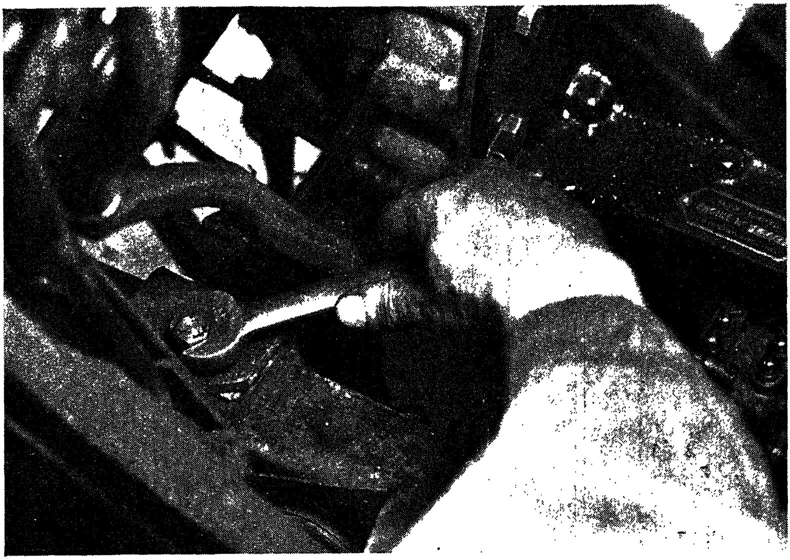


Fig. 10.—ENGINE MOUNTING

Retightening rear engine mounting. This is where most of the weight should be borne (Silver Crest).

forget the crankcase breather pipe, servo pipe from induction pipe to servo brake valve (if fitted), bottom water pipe from pump, and remove the radiator *first*. The aluminium clutch-cover plate should be unbolted, giving access to the rear engine-mounting bolts, which are easily removed; also the front ones, but—a note for reassembly—do not compress the mounting rubbers by bolting too tightly; it destroys their resilience, causing transmission instead of absorption of vibration.

Engine Mounting

When remounting a Silver Crest engine, in which there are three mounting points—i.e. at the front, at the rear of the engine, and at the rear of the gearbox—it is important to see that when the engine rests on its front and intermediate bearers the rear end of the gearbox is not carrying too much weight. In other words, most of the weight should be carried on the centre mountings so that the rear end is left only lightly mounted and the bolts only done up finger tight. If the weight is carried at the front and rear ends, and the centre mountings pulled down tightly, there is a tendency to strain the alignment of the engine, clutch, and gearbox, and this might give rise to roughness.

Engine Lubrication

All Alvis engines are lubricated by means of a simple gear-wheel type oil pump driven by a vertical shaft geared to the camshaft. The pump,

normally, is always below the level of the oil, but on the Silver Crest 17- and 20-h.p. models it is important that the oil be maintained at least at the $1\frac{1}{4}$-gallon mark, or, if a left-hand bend is taken at speed, the pump may be momentarily uncovered.

Quite a number of models up to 1938 had a pressure oil filter through which oil was driven from the pump. It is really important that this type of filter be cleaned every 500 miles. The Silver Crest engine has an external filter which needs renewal at 10,000 miles, but no attention is necessary during its life. In addition, all models have a large circular filter in the sump which should be cleaned when the oil is changed at 1,500–2,000 miles.

Oil Pressure

If complaints are received about low oil pressure on cars which have covered only a small mileage, attention should be given to the oil-relief valve positioned between the oil pump and the main oil gallery. It is designed to return surplus oil back to the sump when the pressure tends to exceed a predetermined limit. It consists of a spring-loaded plunger, the pressure of the spring on the plunger being adjusted by turning a hexagon-headed screw (after, of course, the locknut has been slackened).

Normally no adjustment is necessary, but the cause of low oil-pressure readings must be traced at once, and the first precaution should be to remove the complete valve so that it may be cleaned. Should a fragment of dirt lodge between the valve and its seating, this may keep the valve open and thus cause the low gauge reading.

After overhaul the valve should be set to register a pressure of 40 lb. at an engine speed of 2,000 r.p.m., but it must not be forgotten that the pressure will be greater when the oil is cold, so adjustments should be made with the engine at running temperature.

In cases where pressure filters are used, check to see if they are choked with deposit from the oil. If little oil passes these filters, run big-end bearings are a possible result. After a bearing *has* run, make quite sure all oilways are clear of deposit from the metal. This may mean removing and stripping the engine bottom half. Examine the pressure filter within a very short mileage, and clean again if necessary.

On older engines lower oil pressure will naturally result as wear takes place. After the oil-release valve has been adjusted to the maximum, to restore the pressure the crankshaft should be reground throughout and the bottom half of the engine rebuilt, with new main and big-end bearings. Heavy oil consumption, plus a low oil-pressure reading, does not necessarily indicate badly worn bores. This may be a contributory cause, but in an engine which has had a long life worn condition of the bearings, with excessive side clearances on main and big ends, is more likely to be the trouble.

These clearances are important, and when refitted after the connecting

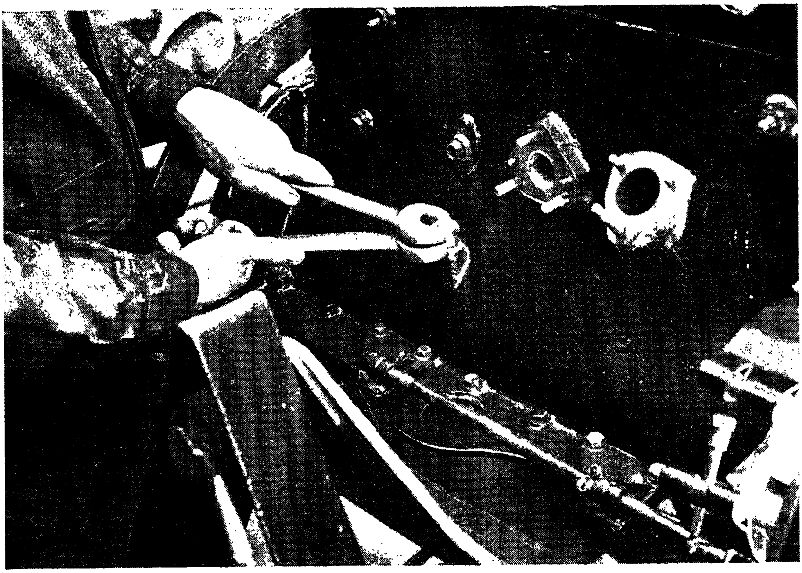


Fig. 11.—Oil pressure
Adjusting oil-release valve.

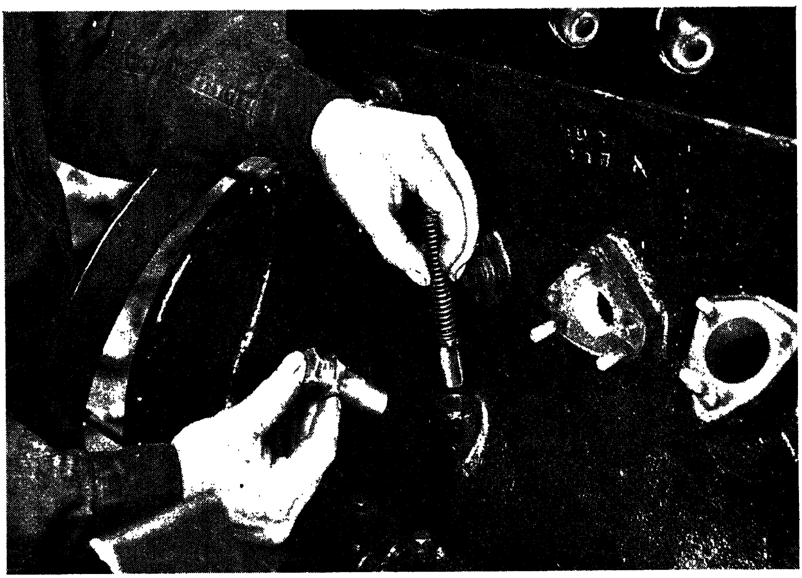


Fig. 12.—Oil Pressure
Oil-release valve assembly removed, showing spring-loaded plunger.

rods have been remetalled the big ends should have a maximum side clearance of ·002 in. only. The rods have die-cast white-metal bearings, so they must be returned complete to the works for remetalling. The only exceptions are the 17-h.p. and 20-h.p. Silver Crest engines, which have detachable Vandervell-type bearings. Side clearances in this case are governed by separate bronze end pads pegged in position and easily renewed.

Carburation

The present range of Alvis cars is fitted throughout with S.U. carburettors, the main components of which are a piston carrying a taper-jet needle which protrudes into the orifice of the jet itself. The piston rises in the body of the carburettor as the throttle is opened ; thus the annular gap between jet and needle increases as the taper jet rises with the piston.

The only possible adjustment is by means of the adjusting nut at the base of the carburettor, and which raises or lowers the jet in relation to the lowest position of the needle. It will be observed that once the carburettor has been adjusted to run correctly at idling speed, it should be correct throughout the entire speed range of the engine.

If the jet is removed, take care when reassembling to centre the jet needle carefully. Screw the adjusting nut to its top position and move the jet right up until its head is against this nut. Then refit the jet, feeling if the piston is perfectly free by lifting it up with the finger. If it is not, slacken the jet screw and try again, as it may be necessary to repeat the operation several times before the piston falls perfectly freely ; but when once accomplished, bring the jet-adjusting nut back to its original position.

Unless care is taken, it is only too easy to bend the needle, in which case it will bind on the jet and thus cause the piston to stick. To test for a bent needle (provided the jet is not out of centre) remove it from the piston, reassemble the carburettor, and see if the piston falls freely. To free a piston sticking for other reasons unscrew the oil cap from the top of the suction chamber, and pour in a few drops of paraffin, after which work the piston until it frees. Add a few drops of *light* machine oil to lubricate the piston rod and bearing.

A further hint if trouble persists : remove the pistons and clean with a little metal polish. Free them from all traces of polish and reinsert.

12/70-Carburettor Insulation

To prevent overheating and consequent vaporising of petrol in the carburettor, an insulating packing can be supplied if necessary to fit between the carburettor and the induction pipe. Cases of difficult starting can generally be cured by this expedient, although in connection with vaporisation the question of baffle plates as detailed in the " Engine " section should not be overlooked. The packing washer is about $\frac{1}{4}$ in. thick.

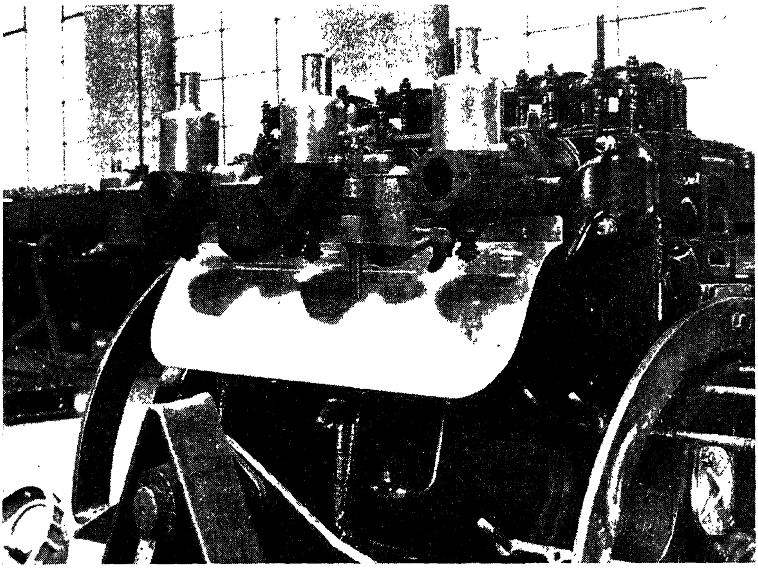


Fig. 13.—PETROL VAPORISATION
Aluminium baffle plate shown fitted to Silver Crest engine.

Petrol Vaporisation

This trouble is recognised by the engine misfiring and spluttering when getting away after a period of slow-traffic work.

If trouble is experienced from this source, it is recommended that an aluminium baffle plate be fitted to insulate the carburettor from the heat rising from the manifold. A suitable baffle may be fitted on the three bottom studs of the manifold, with suitable slots cut to allow for the passage of the carburettor controls. Another suggestion is to saw-cut the induction and exhaust manifold between the flanges, to insulate one from the other.

Blowing Exhaust Joints

Continual blowing of manifold gaskets is generally caused by a distorted manifold face. If this is removed and machined true the trouble usually disappears ; care being taken to fit the new type of Cemjo joints.

Engine Noises

A squeak, which might be mistaken for a magneto squeak, will on occasions be heard on earlier Alvis models, but the noise emanates from directly under the feet when the clutch pedal is engaged. It is caused by failure to grease the spider on the splined clutch shaft, which squeaks as the dry spline of the spider moves along it.

On more recent engines a peculiar chirp when the engine is idling is easily mistaken for a noisy dynamo brush. Actually, however, it is created by the action of the carbon gland of the water pump against its seating, and it has been found that the more efficient the gland the more likely it is for the noise to occur. A simple remedy is the introduction of a few drops of oil into the radiator. Impervious to water, the gland will absorb the oil, immediately silencing the chirp.

17-h.p. Pump Drive

A few 1937 17-h.p. cars have been returned to the works with the water pump out of position. The trouble has proved to be due to the dynamo having been removed and incorrectly refitted. When mounting the dynamo, it should be pushed rearwards into the water pump, which should be fitted in position first. Next draw the dynamo forward 3 mm., which location will give the correct position of the slots or dogs in the end of the dynamo spindle.

Sparking Plugs

Speed 25 and 4·3-litre models were fitted as standard with Champion sparking plugs LA. 10, but the new edition of this plug is known as type L. 10 S. The introduction of the latter was primarily to cope with the higher compression ratios in the 1939 range, but the new plug will function perfectly satisfactorily in the earlier cars, though it is not absolutely essential except on the 1939 cars.

CLUTCH

All modern Alvis clutches are of the single dry plate, which require little attention. The assembly proper requires no lubrication, but the clutch-operating pedal shaft should be greased at the nipple provided once every 1,000 miles.

Clutch pedals on 17- and 20-h.p. Silver Crest models are fitted with oilless bushes, but mud and water thrown up from the road may give rise to tightness. It is recommended in such cases that a grease nipple be incorporated in the boss, so that a grease-gun can be operated from the engine side of the ramp. It will be necessary to build up the boss before drilling and tapping.

Clutch Adjustment

The only clutch adjustment possible is to vary the clearance between the release bearing and release lever plate. There should be at least ½ in. free movement at the clutch pedal pad when it is in the engaged position, but as wear on the clutch linings takes place the tendency will be for the release plate to move nearer the bearing, necessitating adjustment to the wingnut provided. It will be noted that on all models the nut is rotated in an anti-clockwise direction to restore free movement.

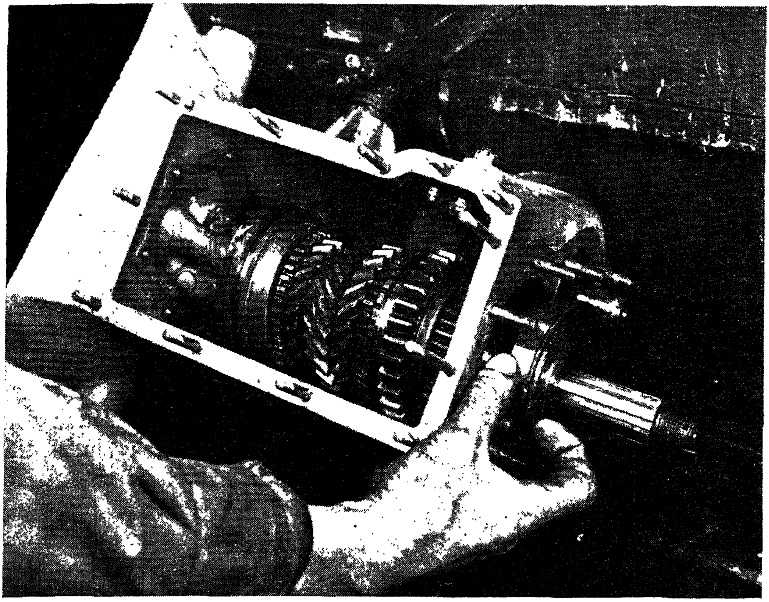


Fig. 14.—DISMANTLING GEARBOX

Extraction of 12/70 gearbox rear mainshaft bearing and mainshaft itself after removal of rear cover.

If the clutch is not freeing properly, making gear changing difficult, it may be that there is *too much* free movement at the pedal.

Clutch Judder

Clutch judder is a complaint occasionally received, and the trouble is usually found to be due to excessive fore-and-aft movement of the power unit. Brackets will be found on the underside of the clutch housing, with corresponding ones on the adjacent chassis cross-member. End float can be adjusted by means of these brackets or plates, and it should be reduced to a minimum without the location pads actually being nipped, or engine vibration will be transmitted to the body.

Points to Watch

The Ferodo blocks on the locator brackets should be kept well smeared with grease to prevent any friction noises. Other points to watch are as follows :

See that on clutches having carbon withdrawal pads, the latter are kept free from grease or oil.

If the clutch is completely dismantled, examine the spigot bearing in the end of the crankshaft. See that it is well lubricated ; partial seizure may cause a spinning clutch.

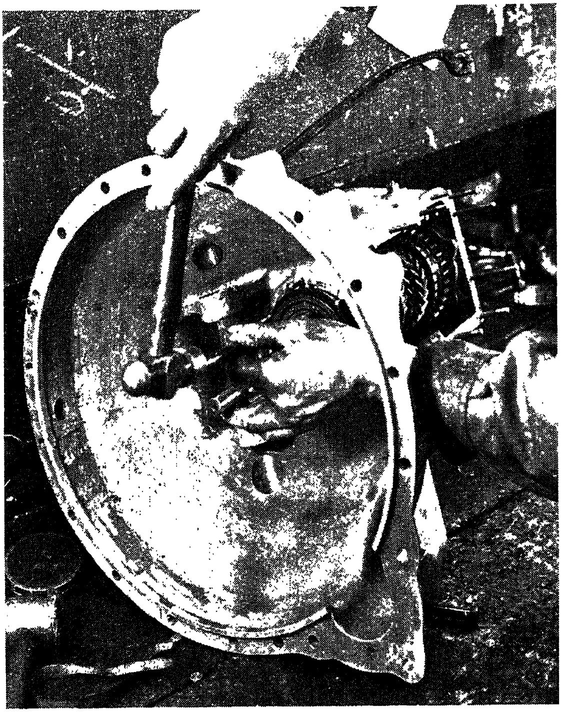


Fig. 15.—DISMANTLING GEARBOX
Tapping out layshaft of 12/70 gearbox from clutch end.

In cases where the flywheel body (which acts as the front pressure plate) is scored, it can usually be refaced satisfactorily by grinding.

A knock when the clutch is taking up the drive may indicate worn splines. Examine both clutch centre lined plate and clutch shaft—this will, of course, entail moving engine on Silver Crest models.

Engine to Gearbox Alignment

On Speed 25, 4·3-litre, Crested Eagle, and many of the earlier models, Hardy flexible couplings are used on the shaft coupling the clutch to the gearbox. When renewal becomes necessary, the alignment between the engine and gearbox should be carefully checked and corrected if necessary. Misalignment will cause rapid wear of these fabric joints, but if, despite care, failure of the joints persists, double-thickness joints should be obtained and fitted (current models only).

Note that the condition of the engine-bearer rubbers is important. Flattened rear mountings should be renewed if correct engine–gearbox alignment is to be obtained, and of course the gearbox rubbers must not be overlooked.

GEARBOX

Procedure for Dismantling All-synchromesh Gearbox

On the larger cars, having a separate four-speed all-synchromesh gearbox, the procedure for dismantling is briefly as follows :

It is first necessary to remove the six long bolts passing through the gearbox casting at either side of the bearings (owing to the exceptional length of this gearbox it is provided with intermediate bearings), after

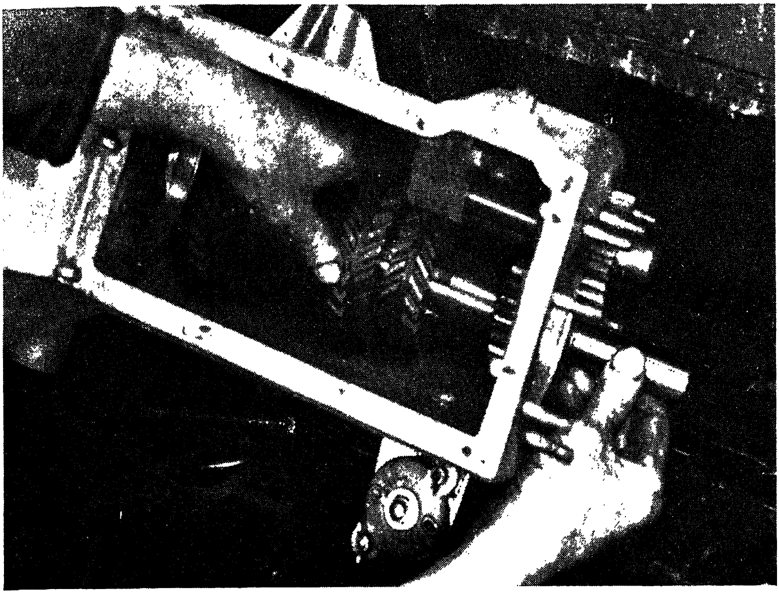


Fig. 16.—DISMANTLING GEARBOX
Finally removing 12/70 layshaft through rear of box.

which the nuts from the studs maintaining the joint between the top and bottom halves of the box should be unscrewed. Next, the coupling flanges from the constant-mesh pinions and the rear end of the mainshaft must be taken off, also the front and rear covers. It will now be possible to lift off the top half of the gearbox complete with selector mechanism, and the whole of the mainshaft together with bearings can be lifted out of the box. The next procedure is to tap the layshaft towards the front end of the gearbox, removing the front roller bearing and first-speed pinion, following which, if the spring ring holding the centre layshaft bearing is removed, the layshaft may be withdrawn by sliding through the bearing. The second- and third- and constant-mesh layshaft gears, being a sliding fit on the layshaft, will be left at the bottom of the box when the shaft is withdrawn.

One of the six long bolts first mentioned passes through the reverse shaft, holding it in position, so that, this bolt removed with the top half of the gearbox, it is possible to pull the reverse shaft out, extraction being facilitated by inserting a $\frac{3}{16}$-in. bolt in the hole specially tapped for this purpose in the end of the shaft.

Removal of Silver Crest and 12/70 Gearbox

Removal of the Silver Crest gearbox can be attained without removing the engine unit, by uncoupling at the propeller-shaft end and unbolting

at the clutch casing. The weight of the engine, however, must first be supported by a jack, before removing the mounting and bolts.

These latter remarks also apply to the 12/70, in which the clutch and gearbox units can be withdrawn rearwards and upwards. If the rear end of the gearbox should foul the floorboard battens which are secured to metal channels on either side of the propeller-shaft, the battens may be sawn through at a distance of 7 in. from the front edge. It will then be found that the gearbox can be extracted quite easily.

On reassembly the loose battens can be refixed to the channel members by drilling and tapping an extra hole in each.

If it is required to remove the constant-mesh pinion and shaft (which forms the main clutch shaft) from the Silver Crest box, it is only necessary to remove the front cover to slide out both front constant-mesh pinions, but the 12/70 box is differently designed, and it will be necessary to lower the layshaft assembly to free the front gears from engagement.

CARS IN STOCK

If for any reason Alvis cars are held in stock for a long period, it is essential that periodic attention should be given in the matter of cylinder lubrication. At least once a month the sparking plugs should be removed, a small quantity of lubricating oil inserted, and the engine moved round by hand for several revolutions. The object, of course, is to prevent any possibility of corrosion setting up on the walls of the bores.

It is also undesirable to leave fuel in the petrol tank for a prolonged period. Modern high-quality fuels, under the action of evaporation and exposure to air, in time go stale, and experience in the works repair shops has shown that if in the case of a very long repair, fuel is left in the tank, it is very difficult to start the engine, and there is a danger of completely choking the system. The remedy is to drain the system completely (carburettor as well) and fill up when the car is ready for the road again. These remarks apply to all brands of petrol.

STARTER LOCATION

Up to approximately August 1937 the starter motor on the 3½-litre and 4·3-litre was located by a dowel which registered in a ⅜-in. hole in the crankcase immediately on the top of the starter motor. On such models great care must be taken when refitting a starter to register the dowel in the locating hole. A few cases have been brought to light where the dowel has not been so registered, consequently the crankcase has been burst, resulting in serious oil leakage and a very expensive repair.

As with the dowel in the position mentioned location is rather a blind operation, the mounting can be modified as follows : Remove the dowel from the starter body, redrill the latter and tap suitably to take the dowel in a horizontal position. A ⅜-in. hole must now be drilled in the joint line of the crankcase and starter-motor housing bracket.

TILLING-STEVENS ENGINE, CLUTCH, AND GEARBOX

PASSENGER (TYPE HA39A7) AND GOODS (TYPE HA39C4) MODELS

By F. J. HUGHES, M.S.A.E., A.M.INST.T.

ENGINE

Four cylinders, 4¼-inch bore, 5½-inch stroke.
Treasury rating, 29 h.p. Swept volume, 5,115 cc.

Output : 46 b.h.p. at 1,000 r.p.m.
66 b.h.p. at 1,500 r.p.m.
74 b.h.p. at 2,000 r.p.m.

Lubrication

Engine oils recommended : Mobiloil B.B., Castrol C., Triple Shell.

The sump contains 3½ gallons of oil when the level is at the highest mark on the dipstick. After every 100 miles' running, fresh oil should, if necessary, be added to bring the level to the "full" mark.

The sump can be drained by the removal of the hexagonal-headed plug which is underneath the front end of the sump and in the centre of the base of the filter.

The filter is of fine-mesh wire gauze and surrounds the oil pump. It can be detached for cleaning after removal of the six screws which secure its flange to the bottom of the sump.

Cleaning of the filter and changing of the oil should take place every 2,000/3,000 miles, until the vehicle has run about 8,000/9,000 miles. After that, less frequent cleaning will be necessary, and the oil can remain unchanged for about 10,000 miles.

Care must be taken when replacing the filter and the drain plug to make the joints oiltight.

The oil-pressure gauge fitted on the instrument board should read approximately 30 lb. per sq. inch at normal engine speeds. When engine is cold, damage to the gauge is likely to occur if the engine is run at too high a speed before the oil has had time to become warm and circulate freely.

The oil-pressure relief valve is fitted at the top of the housing of the

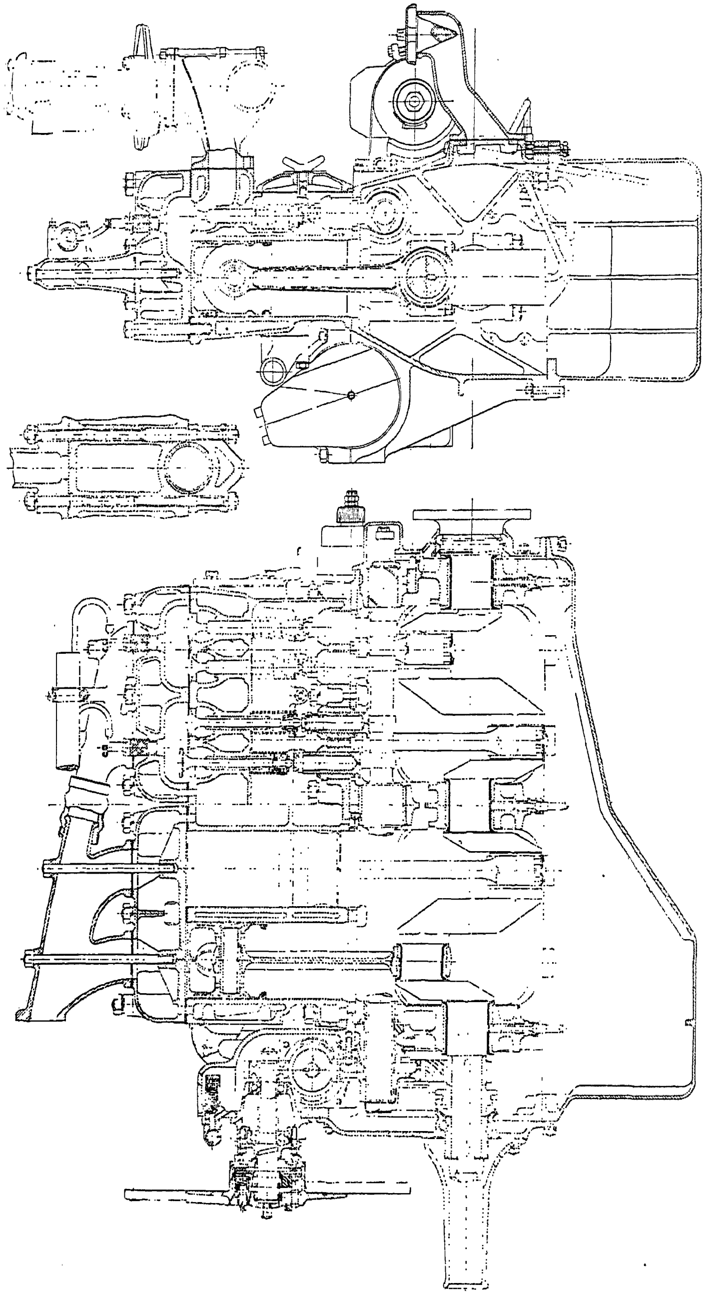


Fig. 1.—SECTIONAL VIEW OF ENGINE

fan-driving gear, and the overflow from it is directed on to the cross-shaft and other gears. The relief valve is correctly adjusted at the works, and no attempt should be made to increase or reduce the pressure by an alteration of the adjustment. If the oil pressure is too high or too low, the cause should be looked for elsewhere and the defect remedied.

The oil pump, which is submerged in the lowest part of the sump, is of the gear type and is driven by skew gear from the front end of the camshaft.

Oil is fed under pressure from the pump to the crankshaft and the camshaft bearings through annealed copper pipes, which are easily detachable for cleaning. The pipes to the camshaft centre and rear bearings, and to the oil relief valve, are outside the crankcase.

The big-end bearings are lubricated from the supply to the mains by straight passages drilled from the crankshaft journals to the crankpins.

Pistons, cylinders, and gudgeon pins are lubricated by oil thrown up from the sides of the big-end bearings.

The cross-shaft and timing gears and the lighting-dynamo chain are lubricated by the overflow from the relief valve ; the intermediate timing-gear bearings are pressure lubricated by an extension from the supply to the front camshaft bearing.

Valve stems and lifters are lubricated by oil mist from the crankcase.

Valves

The valves are of the side-by-side type operated direct from the camshaft by adjustable valve lifters. The lifters are slightly offset in order that wear may be distributed over a large surface.

The inlet and exhaust valves, and also their springs and cotters, are interchangeable.

When the engine is hot the correct clearances are :

Inlet valve . .	·004 inch
Exhaust valve . .	·006 inch

The clearances must be checked periodically and corrected if necessary.

Insufficient clearance will result in a burnt or warped valve head and loss of power.

Excessive clearance will result in overheating, noise, and loss of power.

Valve clearance is adjusted by alteration of the height of the valve-lifter head, which is screwed into the lifter body and secured with a locknut. Special thin spanners for the head and nut are supplied in the tool kit.

The seating angles for both inlet and exhaust valves are 30°.

The inlet valves are masked, by the seatings being recessed $\frac{1}{16}$ inch below the surface of the valve port. On no account should the masking be removed by building up the seating.

Grinding-in is recommended after about 8,000 to 10,000 miles, but the necessity for valve grinding at any particular mileage is dependent on

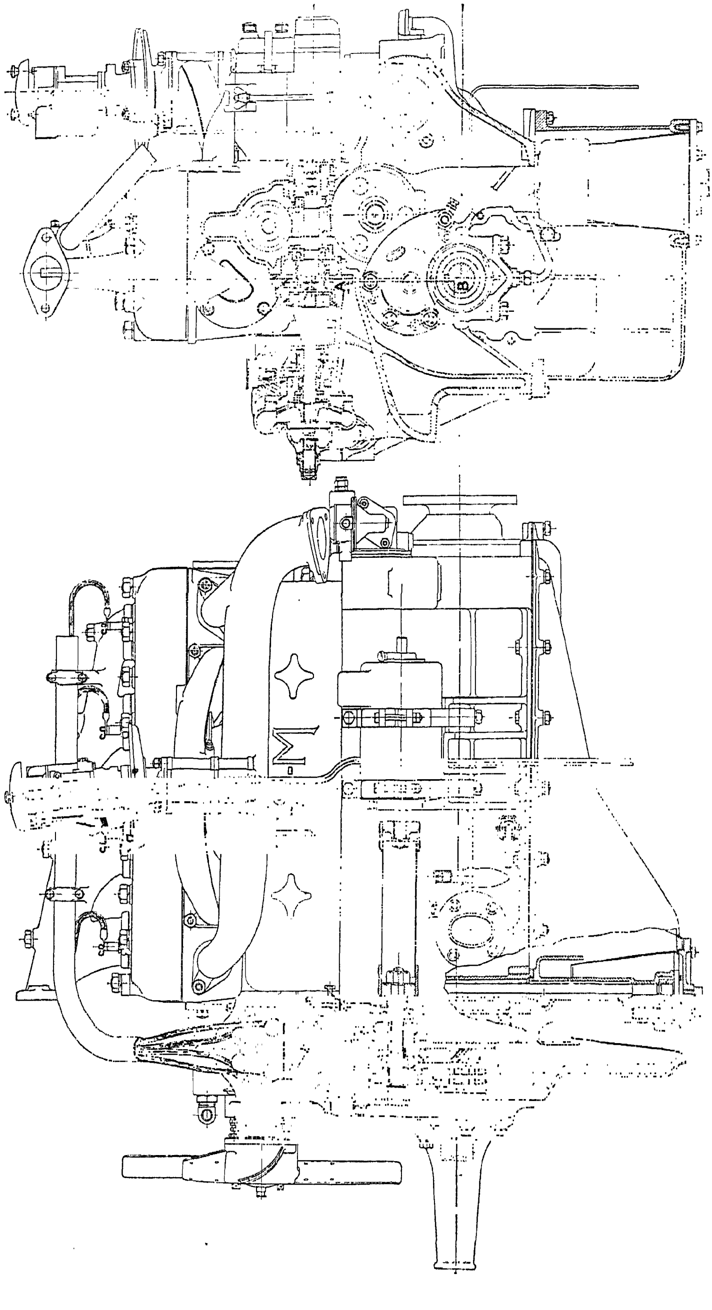


Fig. 2.—SECTIONAL VIEW OF ENGINE

operating conditions and whether or not the clearances have been regularly adjusted.

Valve bounce does not occur until about 2,600 r.p.m., but the engine should not be run up to this speed. If the gaskets of the valve-chest covers become damaged, new ones should be fitted to prevent oil leakage.

Valve-lifter guides are a push-fit in the base of the cylinder block.

Valve Timing

Inlet valves commence to open 10° before T.D.C. and are fully closed 50° after B.D.C.

Exhaust valves commence to open 45° before B.D.C. and are fully closed 15° after T.D.C.

The correct timing angles are indicated by lines scribed on the flywheel rim, which register with a pointer fitted at the rear end of the cylinder block.

Timing Gears

Access to the timing gears is by the removal of the radiator and the centre portion of the front cross-member, and then the timing-case cover.

Helical spur gearing, with an intermediate idler wheel carried in a split housing, is used for driving the camshaft.

The split housing is held in position by four studs passing through clearance holes. A locating setscrew, which bears against the lowest of the studs, prevents any movement of the housing from the correctly set position.

The crankshaft, camshaft, and intermediate gear wheels are all marked to simplify retiming.

Adjustment of Intermediate Timing Wheels

Slacken the four nuts which secure the split housing and loosen the locknut of the locating setscrew.

To *increase* the depth of meshing, screw in the setscrew; this will draw the housing with its gear nearer to the camshaft and crankshaft gear wheels. Temporarily tighten the housing nuts and check the meshing, which should be such that there is an even backlash of approximately ·004 inch to the crankshaft and camshaft gears. It may be necessary to slacken the housing nuts again and to tap the housing into position to get correct engagement of the gears.

To *reduce* the depth of meshing, unscrew the locating setscrew and gently tap the housing away from the crankshaft and camshaft gears.

When the correct position for the housing has been found, the four housing nuts must be well tightened, and the locating setscrew must be tightened and secured by its locknut.

Cross-drive

The cross-shaft, which drives the magneto and the water pump, is mounted on ball bearings and is rotated by skew gear meshing with the camshaft wheel.

The shaft is eccentrically mounted in the bearing housing in order that the skew gear may be adjusted for depth of mesh.

Adjustment of Cross-drive Gears

Remove the water pump with its supporting bracket. Slacken the four nuts which secure the bearing housing to the casing, and rotate the bearing housing in an anti-clockwise direction to increase the depth of mesh.

Not more than about ·002-in. backlash should be allowed in the gears when the engine is cold.

Fan Drive

The fan is driven by skew gear meshing with the cross-shaft gear-wheel. An adjustable spring-loaded friction clutch for driving the fan is fitted outside the fan-gear housing.

The housing, which carries the fan and its drive, is provided with slotted holes for its fixing studs so that the gears may be adjusted for mesh.

Adjustment of Fan-drive Gears

Slacken the four nuts which secure the housing to the casing, and rotate the housing in an anti-clockwise direction to increase the depth of mesh.

A minimum amount of backlash should be allowed in the gears when the engine is cold.

Note.—Silent running of the engine cannot be properly retained unless the engine gears are readjusted for mesh when the backlash becomes excessive. Too much backlash causes "clatter." Too close meshing causes "gear whine."

Pistons

The aluminium-alloy pistons are anodised, and of the solid-skirt type. When new, the clearance at the bottom of the skirt, at right angles to the gudgeon pin, is ·007 in. to ·009 in.

Three pressure rings and one oil-control ring are fitted above the gudgeon pin.

The ring gaps should be not less than ·006 in., and not more than ·010 in., measured when the ring is squarely in the cylinder bore at a position corresponding to the bottom of the stroke.

The clearance of each ring in its groove, when new, is approximately ·001 in.

Rings which have a clearance in the groove exceeding ·008 in. and those that are discoloured on the sides or on the working face, should be rejected.

The gudgeon pin must be an easy push-fit in the connecting rod and a tight push-fit in the piston. Gudgeon-pin fitting is simplified if the piston is first heated by immersion in boiling water or hot oil.

Circlips are used for locating the gudgeon pin in the piston. When a piston is being refitted, special care must always be taken to replace both circlips, otherwise the gudgeon pin will score the cylinder bores.

It is advisable not to attempt the removal of a piston through the bottom of the crankcase, because of the risk of damage while the crankshaft is slowly rotated and the piston manœuvred between the crankcase side and the crankpins.

Sparking Plugs

The use of Lodge sparking plugs, type C.V.L., is recommended (an alternative type is K.L.G. 669 T.S.).

These are three-point plugs and the gaps should be set to ·015 in. Periodical adjustment to this dimension is necessary, otherwise the engine may be difficult to start.

Water Pump

The centrifugal-type water pump, which is driven through a rubber star coupling from the cross-shaft, is carried in an overhanging bracket held by four studs to the cross-shaft housing.

The gland packing consists of a 10½-in. length of ¼-in. square asbestos grease packing, wound spirally round the spindle.

The nitrided-steel spindle runs, at the vane end, in a water-lubricated bush. The gland is lubricated from a screw-down greaser, fitted to the body of the pump.

It is important that the spindle should be lubricated frequently and regularly, and that only a high-melting point grease be used.

Lubricants recommended: Mobilgrease No. 6, Castrol Water Pump Grease, Shell Cup Grease.

Gland Adjustment

To compress the packing, disengage the locking screw from the slot in the rim of the gland nut and turn the gland nut in a right-hand direction. The gland nut should not be more than hand-tight, as excessive compression of the packing is likely to result in rapid wear of the pump spindle. The locking screw must then be refitted in one of the slots and locked with its nut.

The end thrust is taken from the spindle nut by a *lignum vitæ* pad screwed into the pump cover.

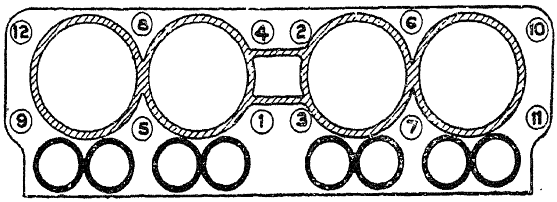


Fig. 3.—REPLACING CYLINDER BLOCK

To avoid uneven stressing of the cylinder block and the possibility of distortion, the holding-down nuts should be tightened evenly in the sequence shown.

End-thrust Adjustment

(1) Remove the adjusting-screw cover.

(2) Slacken the locknut, and screw in the square-headed adjusting screw until a slight resistance to turning can be felt.

(3) Unscrew the adjusting screw a sixth of a turn, and retighten the locknut.

(4) Replace the adjusting-screw cover.

Cylinder Block

The cylinder block is a monobloc casting and has detachable heads in pairs. To remove the block complete with its fittings, proceed, after draining the water and removing the bonnet stay, as follows :

Nearside of Engine

(1) Disconnect the exhaust pipe from the exhaust manifold.

(2) Remove the carburettor starter control-wire from the carburettor, and disconnect the vacuum Servo pipe from the induction manifold.

(3) Disconnect the ignition leads from the distributor, or remove them from the sparking plugs and unclamp the ignition lead tube.

(4) Disconnect the throttle-control rod, either from the throttle lever or from the bracket on the dashboard.

(5) Disconnect the drain pipes from the carburettor tray and induction manifold.

(6) Take off the valve-chest covers and remove all cylinder holding-down nuts that are within reach.

Offside of Engine

(1) Disconnect the water inlet and outlet pipe joints.

(2) Disconnect the magneto-earthing wire from the switch on the dashboard.

(3) Remove the remaining cylinder holding-down nuts. If there is any difficulty in reaching the rear nuts, the electric starter can easily be moved clear by lifting it out of its cradle, after removing the cap.

Sling hooks are formed on the core-hole covers at the front and rear of the block. These should be used, instead of the cylinder-head studs, for lifting the block. While the block is being raised, the pistons should be supported as they leave the bores to prevent damage to them.

Replacement of the block is simplified if the two centre pistons are supported, about three-quarters up the stroke, by wooden blocks under the skirts. When the rings have been entered in the bores, the wooden supports should be removed; the two end pistons can then be inserted in the bores by lowering the block a few inches farther.

The cylinder bores are bevelled at their lower ends to assist the entry of the pistons, but if any difficulty is experienced, a pair of sheet-metal clamps, or chain clips, can be used to compress the rings.

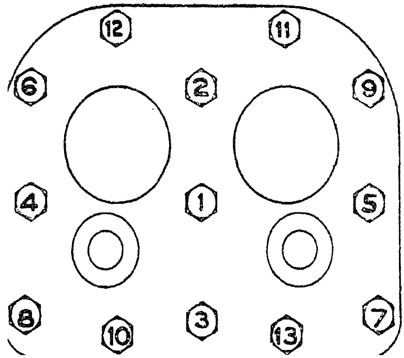


Fig. 4.—REPLACING CYLINDER HEAD

The cylinder-head nuts must be tightened evenly in the sequence shown, each nut being turned a small amount at a time until all are equally tight.

Before the holding-down nuts are tightened, the crankshaft should be turned by hand a few times, to ensure that the pistons are working freely in the bores and the block has settled squarely on the crankcase.

The holding-down nuts should be tightened in rotation by equal increments, starting with the centre ones and working outwards.

Cylinder Heads

Care must be taken when replacing a cylinder head to tighten the nuts in rotation by equal increments, starting with the centre ones and working outwards. After the engine has been thoroughly warmed up, this procedure should be repeated.

The nuts should also be checked for tightness after a day's running in service; this is important, both to prevent water leaks and to avoid burning of the gasket. Excessive force *must not* be used for tightening the nuts; a spanner of standard length only should be used, with a man's normal effort. If excessive tightening appears to be necessary to stop leakage, the gasket should be changed for a new one.

Jointing compound is not necessary, but the surfaces of the gasket, and of the cylinder block and head, must be quite clean and free from any trace of grit.

Carburettor

The carburettor is a Solex, type F.I.L.P., 40 mm., downdraught.

The induction manifold has at its centre a machined boss, the face of which is bolted to a corresponding boss on the exhaust manifold and thus forms an efficient "hot-spot."

Normal Carburettor Setting

Main jet	135
Choke	33
No. 20 assembly	
2 mm. Air bleed	
GA6 (2 GS, 210)	
Slow-running . . .	55/60

Starting the Engine

The throttle should be closed to the minimum idling position (approximately 300 r.p.m.). Pull out the knob marked "Start," switch on the ignition, and then give a sharp pull to the self-starter switch. As soon as the engine fires, release the self-starter switch. The carburettor automatic starter may be left in operation for a short time, but it must be put out of action, by pushing in the knob, immediately the engine will idle without it. This knob must be either fully out or fully in, never in an intermediate position.

A booklet, with description of the Solex carburettor, and instructions for its maintenance, is supplied in the tool kit.

Petrol Tank and Petrol Filter

The petrol tank, 40 gallons' capacity, is slung from the offside chassis frame member, and can easily be detached for cleaning and repairs.

Type HA39C4 has a petrol tank of 26 gallons' capacity.

A petrol filter, of the edge-filtration type, is fitted to the dash on the nearside under the bonnet. The filter bowl should be periodically examined, and wiped clean inside if it is found to contain water or foreign matter.

Petrol Pump

The petrol pump is a Tecalemit type "D," and is driven at half-engine speed by an eccentric at the rear end of the camshaft.

The pump is of the diaphragm type, with spring-loaded inlet and outlet valves, which are easily detachable. A fine-mesh gauze filter is fitted in a domed reservoir at the top of the pump casing.

If it should be necessary for the pump to be dismantled, care must be taken on reassembly to tighten the diaphragm-flange screws equally and gently in rotation.

Access to the filter gauze is obtained by the removal of the domed cover, which is held in place by a milled nut.

In later types this domed cover is secured by a nut and fixed tommy bar. In the event of fuel shortage, first examine this cover for tightness, which is essential to prevent air leakage into the fuel system. Periodically examine cover for this purpose.

The filter should be examined from time to time and cleaned, when necessary, by lightly brushing its upper surface with a non-fluffy cloth.

A small finger lever is fitted at the underside of the pump for priming

purposes. If the carburettor float chamber has been emptied, a dozen strokes of this priming lever will raise sufficient petrol from the tank to the carburettor to enable the engine to be started.

Should the engine stop with the eccentric at its highest position, no resistance to movement of the priming lever will be felt. The engine should, therefore, be turned through one revolution to allow the diaphragm spindle to return to the top of its stroke.

Engine Bearings

The three main bearings and the four big-end bearings are of bronze lined with white metal.

The main-bearing shells are located in the cap by a hollow dowel which forms the oil supply connection.

The crankshaft is located from the rear bearing, where there should be a minimum end play of ·0035 in. and a maximum of ·006 in. The centre and front bearings have a side clearance of about ·030 in.

The big-end bearing shells are located by dowel pegs, and laminated metal shims are fitted between the cap and the rod. The laminations are ·002 in. thick and can easily be peeled off for "taking-up" the bearings. On no account should the cap or the rod be filed.

In renewing or replacing main bearings, it is *essential that the two halves are fitted so that the oil groove is staggered.* If they are assembled with the oil groove forming an unbroken circle, the supply to the big-end bearings will be cut off.

The three camshaft bearing bushes are of cast iron. The centre bearing bush is located by a dowel peg screwed through the face of the crankcase, and the two end ones are held by studs through their flanges. The camshaft end play should be between ·002 in. and ·004 in.

All bearing shells, main-bearing caps, and connecting rods and their caps are numbered, and must always be refitted in their original positions.

Mounting

The engine is flexibly mounted at four points on a sub-frame by "Floatex" bearings arranged vertically. Oil and grease must be kept away from these rubber mountings, and the four holding-down bolts should occasionally be checked for tightness.

Timing the Magneto

The magneto is a Scintilla G.N.4, and its direction of rotation, viewed from the contact-breaker end, is clockwise. The firing order is 1, 3, 4, 2.

The contact-breaker points should have a maximum gap of approximately ·016 in. For normal conditions of running the firing point should be set so that, with the contact-breaker rocker arm two-thirds advanced, the contact-breaker points are just commencing to open when the crank is at 13° before T.D.C. This corresponds to 2 in. before T.D.C. measured on the flywheel rim.

The magneto drive from the cross-shaft is through a B.T.H. adjustable coupling.

Adjustment of the coupling for timing the magneto is made by slackening the $\frac{1}{4}$-in. locknut at the back of the coupling to release the clutch, and then by turning the outer member of the coupling to the required position. The locknut must be carefully retightened, and the timing should be checked.

Adjusting Dynamo Chain

The lighting dynamo is a 12-volt C.A.V.-Bosch type M.R. It is of the compensated voltage-control type, which enables the lamps to be lighted direct with safety. The direction of rotation, viewed from the driving end, is clockwise, and the maximum output is 400 watts.

The dynamo is carried in a cradle on the nearside of the engine, and is driven by a duplex roller chain from the front end of the crankshaft. The driven sprocket shaft is carried by a flanged mounting secured to the timing casing by three studs, two of which pass through slotted holes. Tension of the chain can be adjusted by rocking the flanged mounting after the three securing nuts have been slackened.

A C.A.V.-Bosch control box, type 37AB-2, and panel, type 82–68, are fitted on the dashboard.

Chassis type HA39C4 is fitted with a 12-volt C.A.V.-Bosch dynamo, type DBRS–8 compensated voltage control, maximum output 160 watts.

A C.A.V.-Bosch switchboard, type 6T, and separate cut-out are fitted to the instrument panel.

CLUTCH

General Description

The clutch is of the single-plate dry-disc type, 14-in. diameter. When the clutch pedal is pressed down, the release bearing in turn pushes the inner ends of the release levers forward. The outer ends of the release levers moving to the rear, pull the pressure plate away from the driven-plate assembly, permitting a positive clean release.

When the foot pressure is removed from the clutch pedal, the clutch springs force the pressure plate forward again, the driven plate gradually and smoothly applying the power of the engine to the rear wheels.

Release Bearing Clearance

This bearing, of the " Graphite " type, consists of a " Graphite " ring mounted in a cup or housing attached to the withdrawal fork arms by screwed bolts, the ends of the bolts working in bushed bearings carried in the housing. This type of bearing requires no attention beyond ensuring that the $\frac{1}{16}$-in. release bearing clearance is maintained.

To allow full engagement of the clutch, it is essential that there shall be some free movement between the pedal mechanism and the pressure-

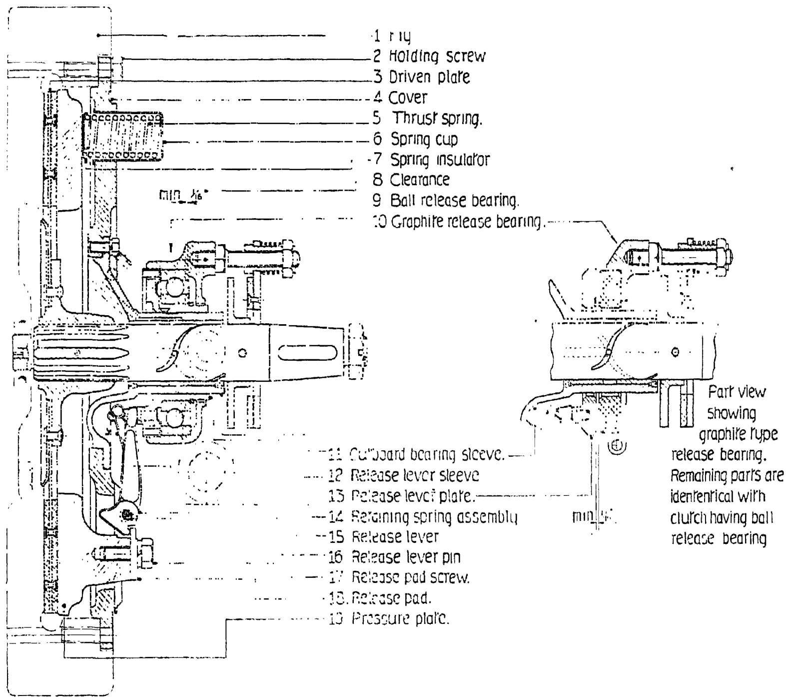


Fig. 5.—The clutch

plate actuating mechanism when the clutch is in the engaged position. To ensure this, a clearance of not less than $\frac{1}{16}$ in. must be provided between the face of the " Graphite " bearing and the release-lever plate.

As the clutch facings wear, the pressure plate moves closer to the flywheel face and the outer or shorter ends of the release levers follow. This causes the inner or longer ends of the levers to travel further towards the gearbox, and decreases the release bearing clearance and free pedal movement referred to above. This free movement must be restored by adjustment on the withdrawal-lever shaft as follows :

Withdrawal-lever Shaft Adjustment

A lever-type adjusting screw is provided at the right-hand end of withdrawal shaft, which if turned in a clockwise direction decreases the release bearing clearance, or anti-clockwise to increase clearance. This is the only clutch adjustment required in dealing with normal wear and tear, apart from the clutch brake adjustment dealt with at a later stage.

To obtain a clean release, the inner ends of the levers should be pushed toward the flywheel approximately $\frac{9}{16}$ in. When the release-lever plate

has travelled this amount, pedal should be in contact with the toe-board, so that no further travel is possible.

Shaft Bearings and Lubrication

The clutch shaft is supported by brass bush bearings carried by an outboard bearing sleeve secured by a flange bolted to the clutch cover.

This sleeve should not be disturbed unless the fitting of new bushes is necessary.

A grease connection is provided on the outboard bearing sleeve for lubricating these bushes, and a small quantity of good quality grease should be applied weekly, based on the vehicle running an average of 160 miles a day.

Clutch-brake Adjustment

With the clutch in the engaged position, the distance between the brake-plate facing and the flange should be maintained at $\frac{3}{8}$ in. Any adjustment necessary can be made by adjusting the sleeve nuts retaining the clutch-brake springs, after slackening off the locknuts situated forward of the sleeve nuts, care being taken to tighten up the locknuts after adjustment.

To Remove Clutch

Slacken off and remove the six bolts in front fabric coupling on clutch shaft, and three on the rear coupling, which enables the entire shaft to be removed. Then remove the two $\frac{5}{16}$-in. bolts at the top end of clutch withdrawal levers, and drive outwards the two yoke pins, which releases the withdrawal bearing. The clutch shaft can then be withdrawn.

It is then necessary to remove the eight holding screws securing the clutch to the flywheel. Loosen each of these holding screws a turn or two at a time until the spring pressure is relieved. The screws can then be removed, and the complete clutch lifted off the flywheel; all parts except driven plate being assembled to the cover.

It is not necessary in this dismantling operation to disturb any fixing or adjustment other than described.

Assemble Clutch to Flywheel

Proceed in the reverse order to the dismantling operations; care should be exercised, when placing driven plate in flywheel, to be sure that chamfer end of hub of the drive plate is toward the outside. The eight screws securing the cover should be pulled up an equal amount each until right home.

General Clutch Instructions

Do not drive with foot on clutch pedal.

Do not slip clutch excessively instead of changing gears, as this causes rapid wear of clutch facings.

Do not put oil, grease, or paraffin in the clutch.
Keep facings dry and free from oil.

GEARBOX

Oils recommended : Mobiloil " C," Castrol " D," Shell Spirax.

Removing Gearbox from Chassis

The gearbox is a separate unit supported on two chassis cross-members at three points. The box can be dismantled from chassis by :

(1) Removing two bolts on front clamping piece, and the two nuts on the mounting at rear of box.

(2) Disconnecting propeller-shaft flange by removing the eight bolts.

(3) Disconnecting speedometer drive and grease connection, then removing three bolts in fabric coupling on clutch shaft.

(4) Disconnecting change-speed control by removing the three $\frac{5}{16}$-in. bolts in circular flange, after which the box complete can be lifted clear of the chassis.

The first motion shaft runs in two large ball journal bearings carried in a steel housing bolted to the front of the box.

The sliding gear-shaft has a ball and roller bearing in a housing at the rear end. At the front end it runs on a roller bearing in the first motion shaft.

The fixed gear-shaft runs in a ball bearing at the front end and a roller bearing at the rear end.

The fixed as well as the sliding gears are splined to their shaft.

The reverse gear is phosphor-bronze bushed and runs on a hardened steel shaft.

Dismantling Gearbox

To dismantle the box, first remove the speedometer drive at the rear and the six nuts holding the sliding gear shaft housing at the rear of the box. By inserting a small chisel bar between the end of the first motion shaft and the end of the sliding gear-shaft, the latter shaft can be levered out, and the gears lifted out of their selector forks.

To remove the first motion shaft, remove the five nuts holding the housing, and with a bar drive out the complete shaft from the rear of the box.

To dismantle the fixed gear-shaft, remove the end covers, undo the grub-screw and the nut at the rear end of the shaft. By inserting a bar between the second and third gears, the ball race, together with its housing and the first gear, can be levered off the shaft. A block of wood should then be placed at the end of the shaft and the shaft driven out from the rear, leaving the remaining gears loose in the box.

To remove the reverse shaft, unscrew the locking screw at the front

of the box and drive out the shaft from the rear. The gear may then be lifted out of its fork.

The box should be assembled in the reverse order of dismantling.

The gear ratios are as follows :

Top	1 to 1
3rd	1·64 to 1
2nd	2·98 to 1
1st	4·89 to 1
Reverse . . .	4·06 to 1

The correct oil level is just below rear end of mainshaft.

SPECIAL POINTS TO BE WATCHED WHEN REPAIRING GUY COMMERCIAL VEHICLES

THE ENGINE, CLUTCH, AND GEARBOX

By R. A. BISHOP

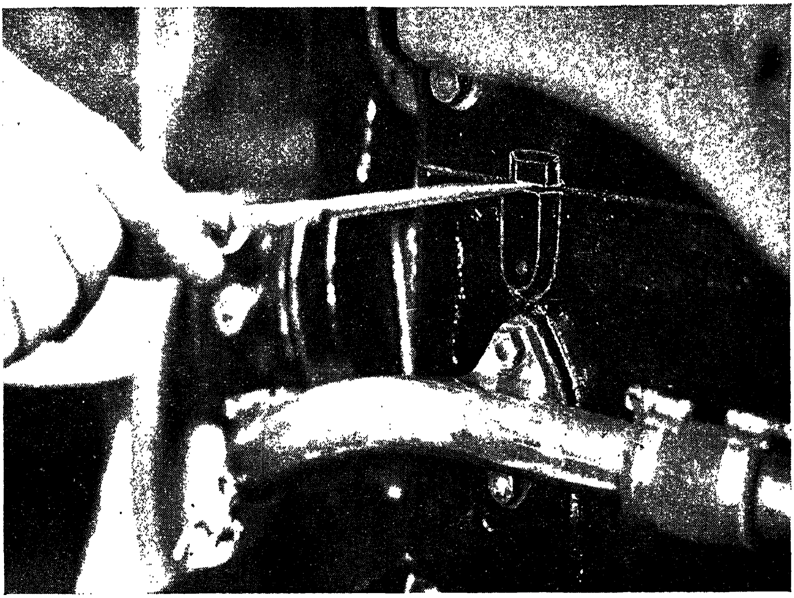


Fig. 1.—BREAKING CYLINDER-HEAD JOINT
Showing lugs on head and block. The head may be lifted by prising gently with a screwdriver at these points.

THE majority of Guy vehicles now built for commercial use are of the overhead-valve four-cylinder type, a design adopted about nine years ago. The engines are produced in two sizes, namely 90-mm. and 95-mm. bore, but they are otherwise identical in all main respects.

It is not proposed to cover the inclined-valve type, which has been largely superseded by the overhead-valve design, for this type is used only in the heavier machines built mainly for military purposes.

The Guy vehicles dealt with here are known as the Wolf delivery van and 2-tonner, Vixen 3/4-tonner, and Otter 6-tonner, besides passenger vehicles of up to 26 seats' capacity. Goods vehicles are built to operate within the £30 tax class and therefore at a maximum speed of 30 m.p.h.

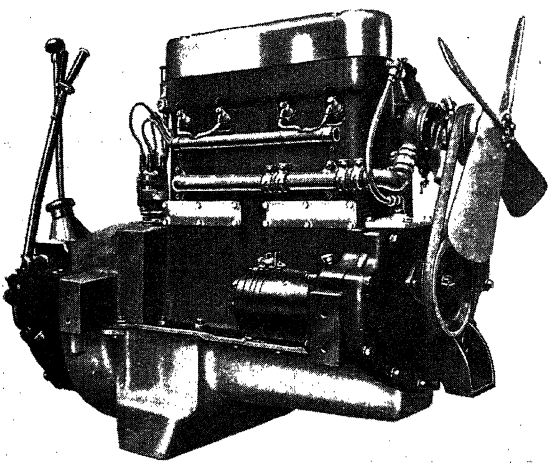


Fig. 2.—OFFSIDE OF ENGINE

The two plates secured to the cylinder block are inspection covers for examining tappets.

Engine Specification

Briefly, the specification of the engine is as follows:

90- and 95-mm. bore and 130-mm. stroke, developing maximum torque at low engine speeds. The crankcase is heavily webbed and the crankshaft is of large diameter. Combustion chambers are designed to promote most rapid flame propagation and are machined to definite dimensions to ensure uniform compression. Forced-feed lubrication is employed, oil being delivered under pressure to main and big-end bearings, timing wheels, valve gear, and connecting rods.

The engine is mounted at three points on special anti-vibration rubber buffers.

It is not the intention here to give suggestions for maintenance along what might be termed routine lines, but to deal with those points which are particularly applicable to vehicles of the Guy type, and to endeavour to impress those features which, though usual, are essential at various stages of the vehicle's life.

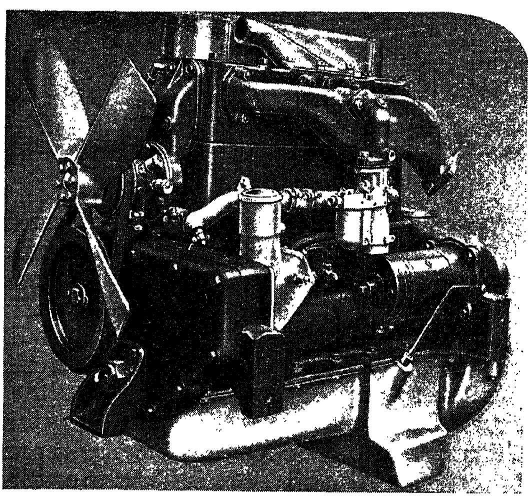


Fig. 3.—NEARSIDE OF ENGINE

When the Vehicle is New

After the first 500 miles such parts as valve gear and gaskets settle down, and it is

therefore advisable to check over all holding-down bolts and valve clearances. To effect this, commence with the cylinder-head bolts at the centre and work out evenly to either side, tightening each one in turn, together with the induction and exhaust-manifold bolts. The valve clearances should be ·006 in. for inlets and ·008 in. for exhausts, when the engine is cold.

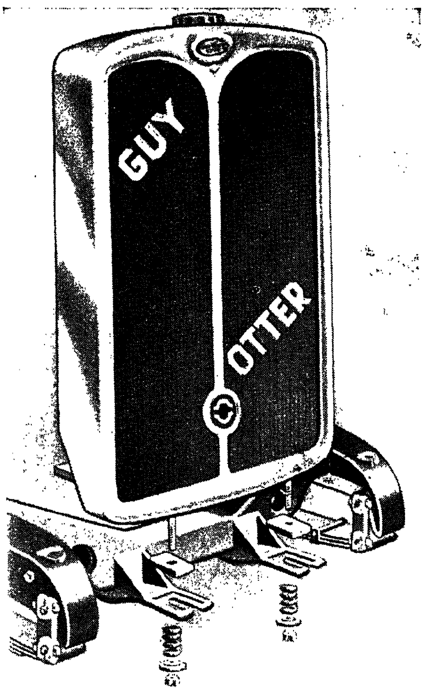


Fig. 4.—METHOD OF FIXING RADIATOR

By slackening off the two nuts under the slotted base brackets and removing the bolts from the radiator stay rods, the radiator can be drawn off the chassis.

Tappet Adjustment

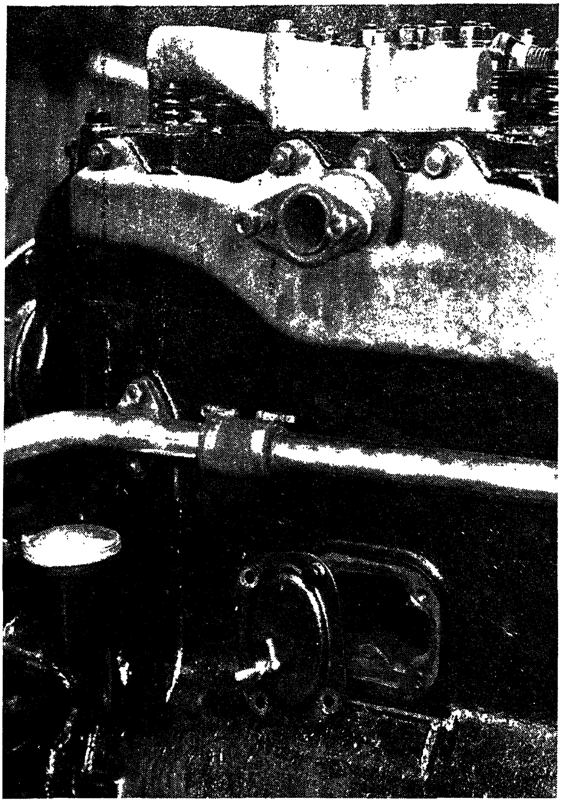
With the valve cover removed, the engine should be turned by hand until the valve to be adjusted is on its seat, and then another quarter of a revolution to ensure that the push rod is at the bottom of its stroke. Insert the feeler gauge between the rocker and valve stem, slacken off the adjusting nut at the opposite end of the rocker, and screw down the adjusting screw until the feeler gauge is nipped. Then slacken the screw back slightly so that the feeler can be withdrawn, and tighten the locking nut. If it is then possible to insert a ·001-in. over-size feeler gauge between the rocker and valve stem, the clearance is too great, and it will be necessary to repeat the adjusting process.

Before we leave this item, it will be noticed that the rockers can be removed complete in one operation once the twelve securing nuts have been released. The rockers are spring-loaded to offset side thrust.

The two plates secured to the cylinder block, each by means of six nuts (Fig. 2), are inspection covers for examining tappets.

Decarbonising

The radiator drain-plug is situated on the offside of the bottom tank. It will be noted that much time is saved by the method of fixing the radiator, as it is merely necessary to slacken off two nuts under the slotted base brackets and remove the bolts from the radiator stay rods,



5.—WATER JACKET INSPECTION PLATE REMOVED FOR CLEANING WATER JACKET

when the radiator can be drawn, not lifted, off the chassis (Fig. 4).

The cylinder head may be lifted when the stud nuts securing the head to the block have been taken off. It will be noticed that small projections are located on the head and block to facilitate the work of breaking the joint and to safeguard the gasket. The head may be lifted by prising gently with a screwdriver at these points.

On the nearside of the engine (Fig. 5) a water-jacket inspection plate is affixed to the cylinder block by means of four nuts. At every decarbonising period this should be removed and the exposed space thoroughly cleaned out, to assist water circulation and cooling.

In valve grinding, care should be taken not to mix the valves. It is advisable entirely to complete one at a time, and replace before commencing another.

Valve Timing

When the line on the flywheel face marked 1/4 is at the top dead centre, the pistons Nos. 1 and 4 will be at the top of their strokes. To check the timing, move the flywheel slightly to the left from the top dead-centre mark, looking at the flywheel from the driver's seat, and, as the inlet valve commences to open on the top dead centre, the rocker screw should be gradually getting nearer to the valve stem, or, in other words, the clear-

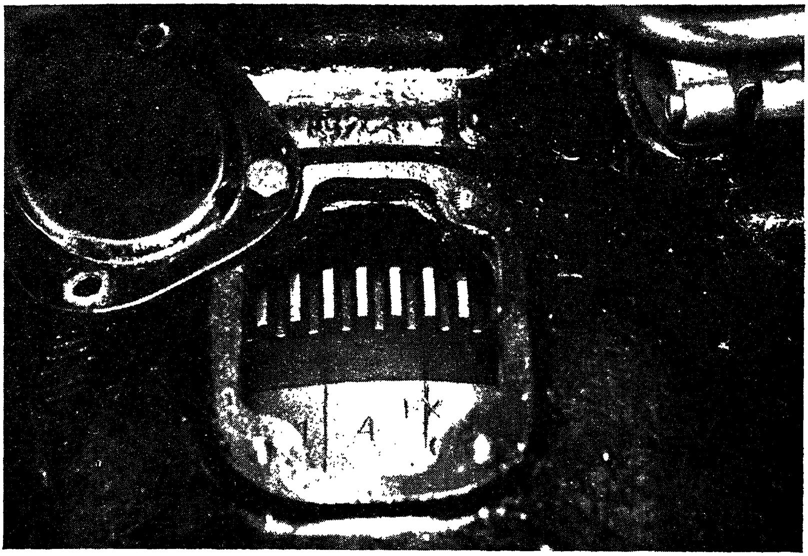


Fig. 6.—TOP DEAD CENTRE AND VALVE TIMING MARKS ON FLYWHEEL

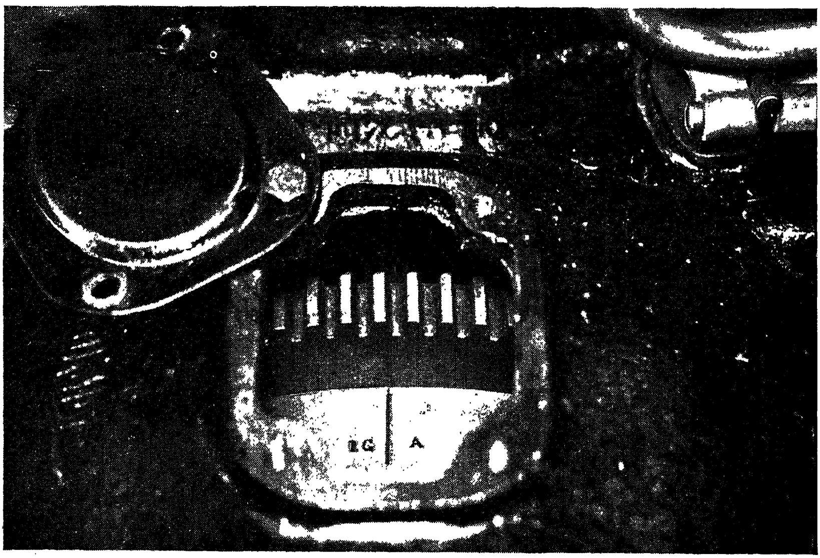


Fig. 7.—POSITION OF FLYWHEEL WHEN POINTS ARE JUST BREAKING WITH IGNITION ADVANCED

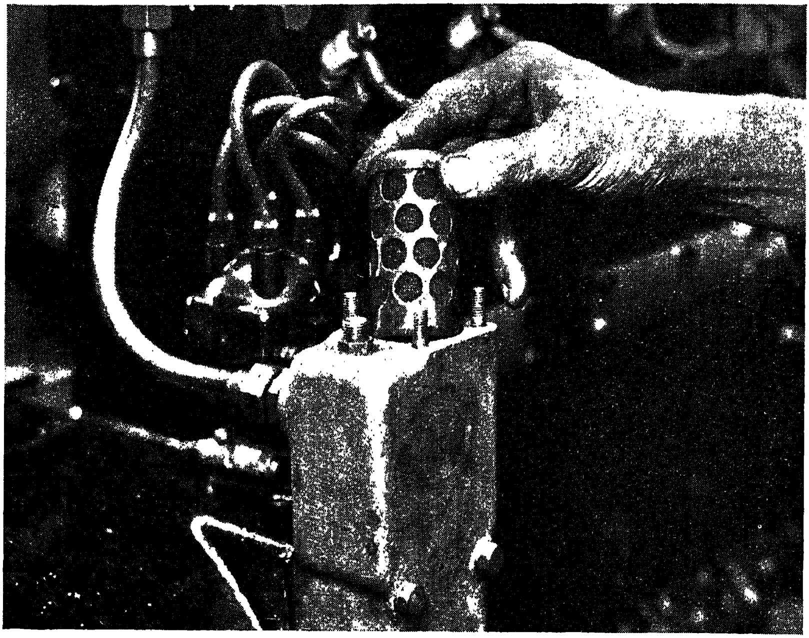


Fig. 8.—Removing oil filter for cleaning

ance is being continually reduced until the screw is touching the valve stem, after which the valve is gradually depressed until fully open.

The opening and closing of the other valves should now be correct, as this is fixed by the camshaft. If incorrect, the rocker clearance is incorrectly adjusted. Each rocker should be tested in turn.

Timing Ignition

When necessary to retime the ignition, proceed as follows :

(1) Fully advance spark lever on steering wheel.

(2) Remove the valve cover from top of engine, so that valve action may be noted.

(3) Remove distributor cap and check contact-breaker-point gap by means of the spanner provided. Loosen distributor head clamping screw and rotate distributor head until breaker points open to their maximum opening. Check this opening, using a feeler gauge, and, if incorrect, loosen the contact-point adjustment-screw locknut and turn the adjustment screw until the gap is ·020-in. Tighten the adjustment screw locknut.

(4) With the ignition switched off, turn the engine by hand until N . 1 cylinder inlet valve closes. The lines 1/4 should then be at the top dead centre of the flywheel. Continue to turn the flywheel to the right for

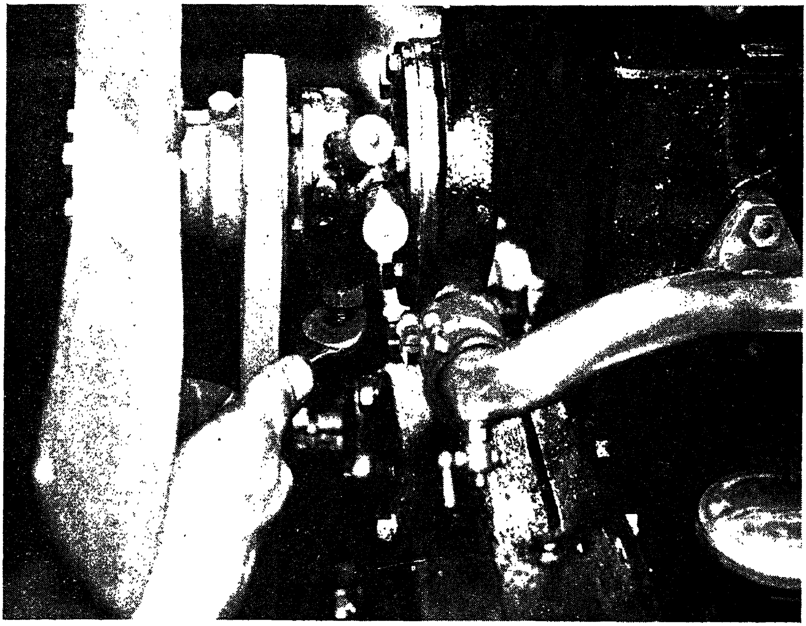


Fig. 9.—TIGHTENING UP WATER-PUMP PACKING

50·4° (17½ teeth), which is equivalent to 6 inches on the periphery of the flywheel. This is the position for firing on No. 1 cylinder.

Oil-pressure Filter

This is located at the offside rear of the engine, and should be washed in paraffin each week and whenever the oil is drained from the sump. Undo the four nuts and remove the cover, when the filter is easily withdrawn. This can be done without loss of oil.

To Clean Oil Filter

The oil is filtered on its return to the sump and before reaching the pump by the cylindrical filter fitted in the bottom half of the crankcase. This may be done by removing the filter, which should be carefully cleaned before replacing.

Crankshaft and Bearings

At the forward end of the crankshaft, an oil retainer known as a gitseal is fitted. Though it is not anticipated that this will require replacement except at periodical thorough overhauls, access to it is obtained by removing the fan pulley, the engine-bearer front suspension bracket, and the timing cover, a simple process on a Guy engine in view of the ease with which the radiator is removed.

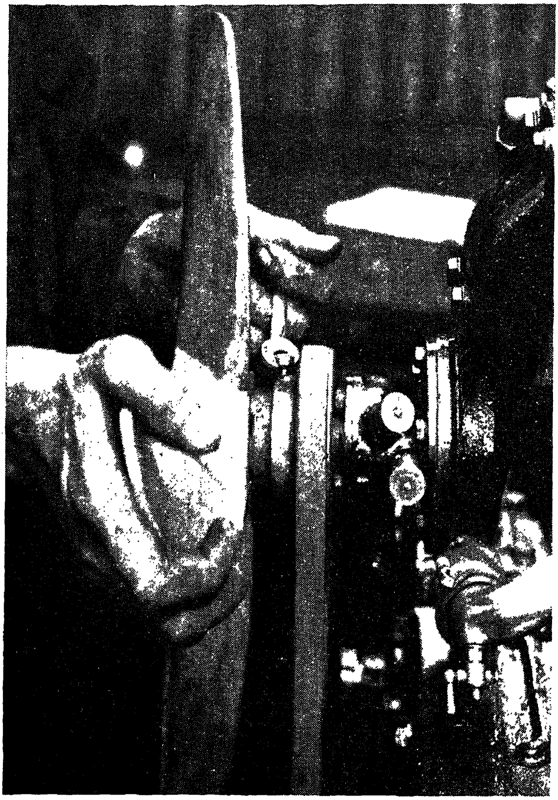


Fig. 10.—TIGHTENING UP FAN BELT

The mains and big ends are all fitted with removable shell bearings in two halves. Adjustment for wear is provided by the fitting of laminated shims. To carry out this adjustment the crankcase may be dropped to expose the bearings, and the shims are revealed when the bearing half has been removed.

The Water Pump

It is not necessary to remove the water pump to repack the glands, adjustment is obtained by slackening off the locknut (Fig. 9) and turning the screw to the right until it is slightly more than finger tight. When all adjustment is eventually taken up and it is necessary to repack, remove the screw and insert a fresh portion of the packing into the hole. Then replace the screw until it is slightly more than finger tight and tighten the locknut.

Fan Belt Adjustment

This is achieved by means of an adjustable pulley at the rear of the fan. To take up slackness in the belt remove the setscrew (Fig. 10) which locks the screwed flange of the main hub. Then, with the engine stationary, pull the fan round in an anti-clockwise direction until the belt is sufficiently tight. Replace the setscrew, making sure that it is located in one of the three slots provided for it in the fan hub.

Engine Suspension

As has already been noted, the engine is suspended at three points in the chassis by means of bearer arms which are detachable from the engine

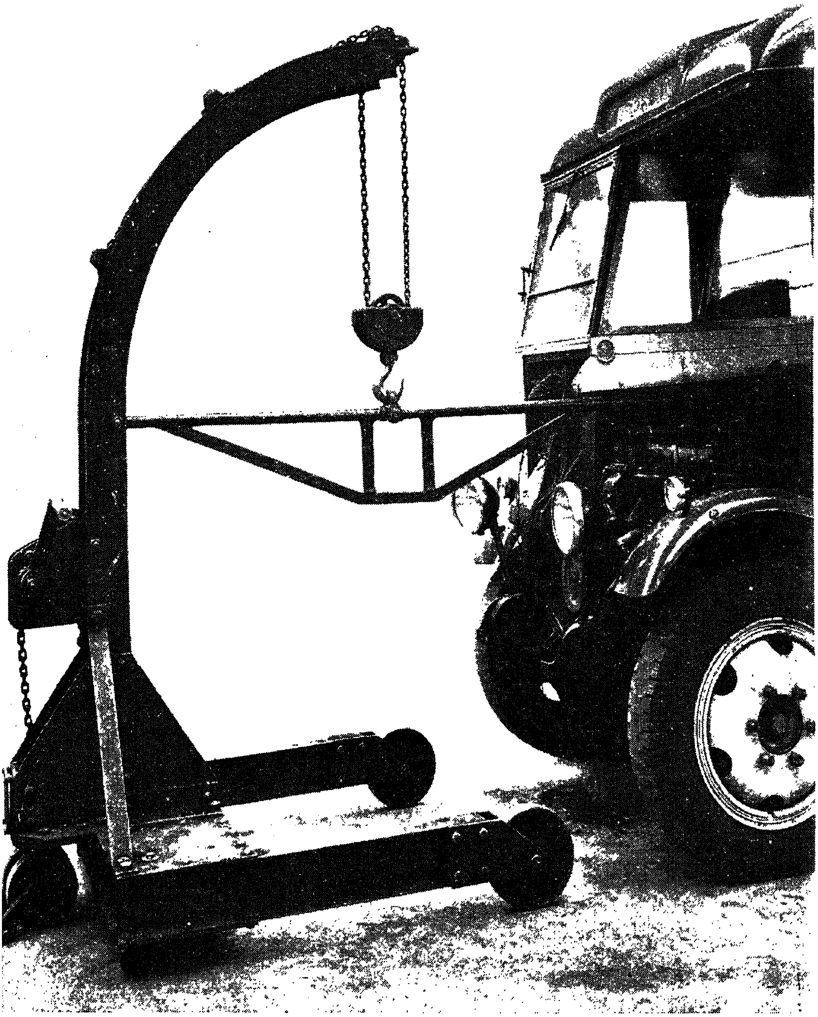


Fig. 11.—REMOVING ENGINE ON FORWARD CONTROL GUY VEHICLE

It is not necessary to remove the cab to take out the engine. Showing equipment used to save time. With radiator removed, the equipment is wheeled to the vehicle and the tackle at the end of the bar attached to the engine by means of two nuts screwed over the cylinder studs. The engine may then be lowered into a pit.

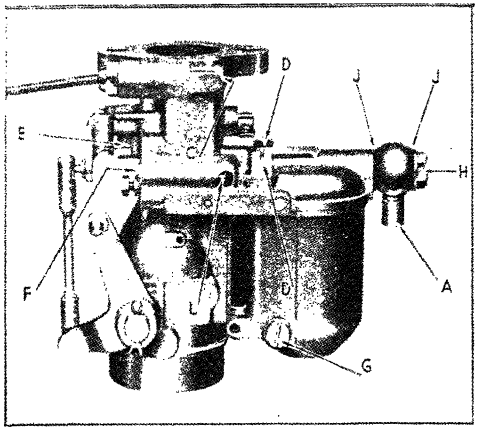


Fig. 12.—STANDARD CARBURETTOR (ZENITH TYPE 33 V.E.M.)

case. When these are released, the engine may be dropped through the chassis to a pit.

Removing the Engine

It is not necessary to remove the cab of a forward-control Guy vehicle to take out the engine. The accompanying illustration (Fig. 11) shows the manner in which a large amount of time is saved in Guy repair shops, and it would undoubtedly pay large operators who carry out complete overhauls to adopt a similar device. With the radiator removed, this equipment is wheeled to the vehicle and the tackle at the end of the bar attached to the engine by means of two nuts screwed over the cylinder studs. The engine is then lowered into a pit.

Carburettor

The standard carburettor is the Zenith type 33 V.E.M. (Fig. 12). The petrol passes from the tank through the union, the filter, and the needle seating in the float chamber. The float rises, and when reaching a certain determined height will press the needle on to its seating, thus regulating the petrol flow. The float chamber contains the main jet, compensating jet, compensating valve, slow-running jet, and starter jet G. From the jet the petrol flows along two separate channels into a common channel in the emulsion block, which is attached to the float chamber. As the petrol in the compensating well is in direct communication with the air and with the emulsion block, all the petrol from the jet and well is centred in one channel in the emulsion block.

This channel leads to a nozzle that projects directly into the choke tube. A special jet is provided for slow running and the petrol is drawn through this jet into a channel which leads to the engine side of the throttle. The petrol is atomised immediately on leaving the jet by air entering the carburettor at the base of the adjusting screw F, which is the shorter spring-loaded screw.

The Automatic Starting Device

This device should be considered as a separate carburettor, specially designed to start the engine immediately from cold, and to ensure an instant get-away when necessary.

It is operated by a control, fitted on the dashboard in the case of normal-control vehicles, and on the top engine shield to the left of the driver on forward-control models.

In order to start the engine, pull out the starting-device control and, keeping it in this position, turn the engine over a few times on the starter or by hand. Then switch on the ignition, and on once more operating the starter, the engine will fire immediately and continue to run. It will be found that the engine runs at a sufficient speed for the vehicle to be manœuvred out of the garage without touching the accelerator. By reason of the automatic starting device the engine can be started and driven away immediately, even from cold when necessary, without fear of causing cylinder wear or crankcase dilution owing to an excess of liquid petrol.

It is quite in order to leave the starting device in action for the first mile or so to assist warming up. The controls must then be released to the normal position. But under no circumstances must the throttle be opened beyond the idling position, or the accelerator touched when starting. The efficiency of the automatic starting device depends entirely upon the throttle being closed to the idling position.

Carburettor-jet Settings

When a vehicle leaves the works, the carburettor has been set to provide the best engine performance under all general conditions, and it is unlikely that any alteration is required. The standard settings used are as follows:

Choke tube	27
Main Jet	121 cc.
Compensator jet	160 cc.
Slow-running jet	70
Progression jet	100
Needle seating	2·0 mm
Starter jet	120
Starter sleeve	4·5
Starter venturi	5·5

Dismantling the Carburettor

If you have trouble with your engine, do not assume that it is always due to the carburettor. If you are satisfied that the carburettor is completely free from dirt (jets, needle, seating, etc.), do not be tempted to interfere with the carburettor until you have gone over the possible causes of trouble, such as sparking plug and timing ignition, see that the valves are not sticking, and other such details.

Before dismantling the carburettor turn off the petrol. The bowl can then be removed by taking out the holding-down screws D. The hand should be placed underneath the bowl during this operation so that when

the screws are removed the bowl will drop into the hands. The petrol in the bowl should then be emptied back into the tank. On turning the bowl upside down the float will slide out and reveal the main and compensating jets at the bottom.

The jets should be removed occasionally and thoroughly cleaned. One of the holding-down screws D is squared at the end to fix into the jet. When the bottom end is placed into the jet, a spanner applied to the head of the screws will enable the jet to be removed.

On cleaning the jets do not pass anything through them that is likely to damage the carefully calibrated orifices. The most satisfactory and efficient method is to blow through them and wash them in petrol. This will remove any obstruction and leave the jets undamaged. The sizes of all jets are clearly numbered and the bigger the jet the larger the number.

Slow running is adjusted by means of the throttle stop-screw E and the air-regulating screw F. The stop-screw E determines the speed of the slow running (i.e. it adjusts the throttle position for idling). To increase the slow-running speed the stop-screw must be turned in a clockwise direction. If turned in the opposite direction, a slower tick-over will be given.

The richness of the slow-running mixture is adjusted by the air-regulating screw F. Should the engine refuse to tick over for any length of time, or stall on deceleration, it is a sign that the slow-running mixture is weak. To overcome this it is necessary only to enrich the mixture by turning the regulating screw in a clockwise direction. If the engine is inclined to "hunt" when running slowly, the mixture is too rich and must be weakened by turning the air-regulating screw in an anti-clockwise direction. The best position for the slow-running screw from the point of view of pick-up is within one turn of the "home" position.

There are other factors, quite apart from the carburettor, that have a great influence on the tick-over of the engine. Unsatisfactory slow running may be due to: (1) Joints not airtight. (2) Valve guides worn. (3) Valves not seating. (4) Ignition too far advanced. (5) Incorrect setting of sparking-plug points.

Difficult Starting

If the procedure for starting already described is followed and the engine still will not start, the following points should be carefully checked:

See that there is no air-leak between the carburettor and the cylinders. This is a common cause of difficult starting.

Make sure that the starting jet G is clean and that the sleeve L of the air valve is not sticking.

See that when the dash control is operated the main valve comes completely off its seating and fully uncovers the orifice on the engine side of the throttle. The latter can be checked by finding if it is possible to pull the valve out farther when the control is fully extended.

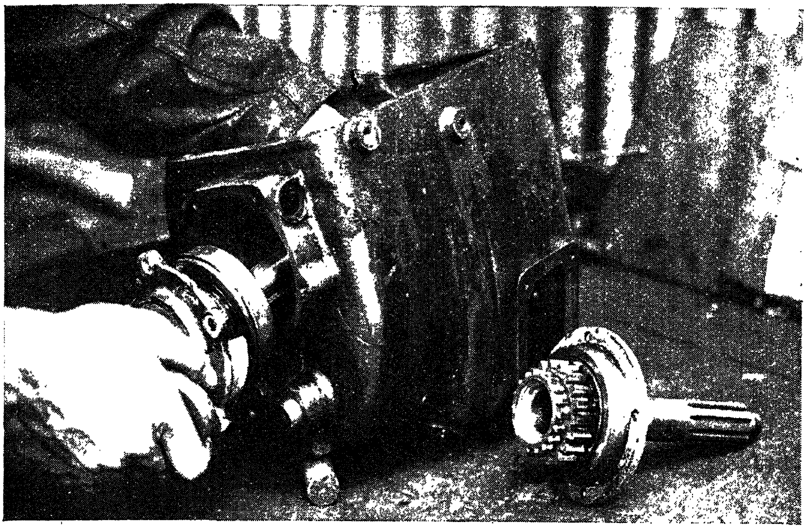


Fig. 13.—DISMANTLING GEARBOX
Withdrawing mainshaft, showing primary shaft withdrawn.

The Filter

The petrol is filtered on entering the carburettor, and the filter should be cleaned from time to time. To remove this item, unscrew the petrol connection H and take the filter out of its seating. The gauze can then be thoroughly cleaned with petrol.

When reassembling the filter, care should be taken to see that the washers J are correctly replaced.

The Autovac

The filter in the main petrol-supply connection at the top of the instrument should be cleaned each month. Access to it is obtained by disconnecting the pipe at the elbow, slackening off the clamping nut, and removing the elbow. The filter cone then lies beneath. If the elbow is tight, grip it between the jaws of a spanner and turn so as not to damage the pipe. The elbows should not be changed over, and care should be taken to see that the one with the valve fitted is the suction elbow.

It seems almost unnecessary to mention that the vent holes in the cone and tank should be kept clear, but troubles have been traced to these holes being plugged up.

Once a week the sediment trap should be cleared by opening the drain tap. If the petrol does not then flow freely, pass a fine wire through the tap to clear the sediment.

It is not necessary to prime the autovac in the event of it becoming completely empty. Simply close the carburettor throttle and turn the



Fig. 14.—ADJUSTING CLUTCH

engine by hand or starter, when, if the engine is run for a short time, the tank will become full.

The Gearbox

To top up at 2,000 miles' intervals, remove the oil-level plug on offside of the box, unscrew the cap at the base of the gear lever, and lift up the lever. When replacing, see that the slot in the change-speed ball is in line with the peg, no force being necessary to refit the lever.

When the nuts holding the selector cover to the gearbox casing are removed, the cover, complete with change-speed lever, selector rods, and forks, can be lifted off the box. But if the selector pins are removed care must be taken not to drop the locking pins which operate between the rods, and so prevent more than one gear being engaged at a time. When replacing the cover, the forks must fall correctly into the grooves on their respective gears.

The main shaft may be drawn out complete with rear ball race after removing the rear coupling and the rear gearbox cover. As the main shaft is withdrawn the two sliding gears can be lifted out from above. The layshaft and reverse shaft spindles are locked by a small plate on the rear face of the gearbox. When this is removed both shafts may be withdrawn through the rear face of the box. $\frac{3}{8}$-in. B.S.F. tapped holes in the ends of the spindles greatly assist the withdrawal. After withdrawing the shaft, the layshaft gears and the reverse wheel can be withdrawn through the top of the box. The layshaft bearing and distance-piece come out with the layshaft cluster.

The primary shaft may be removed from the front after removing the

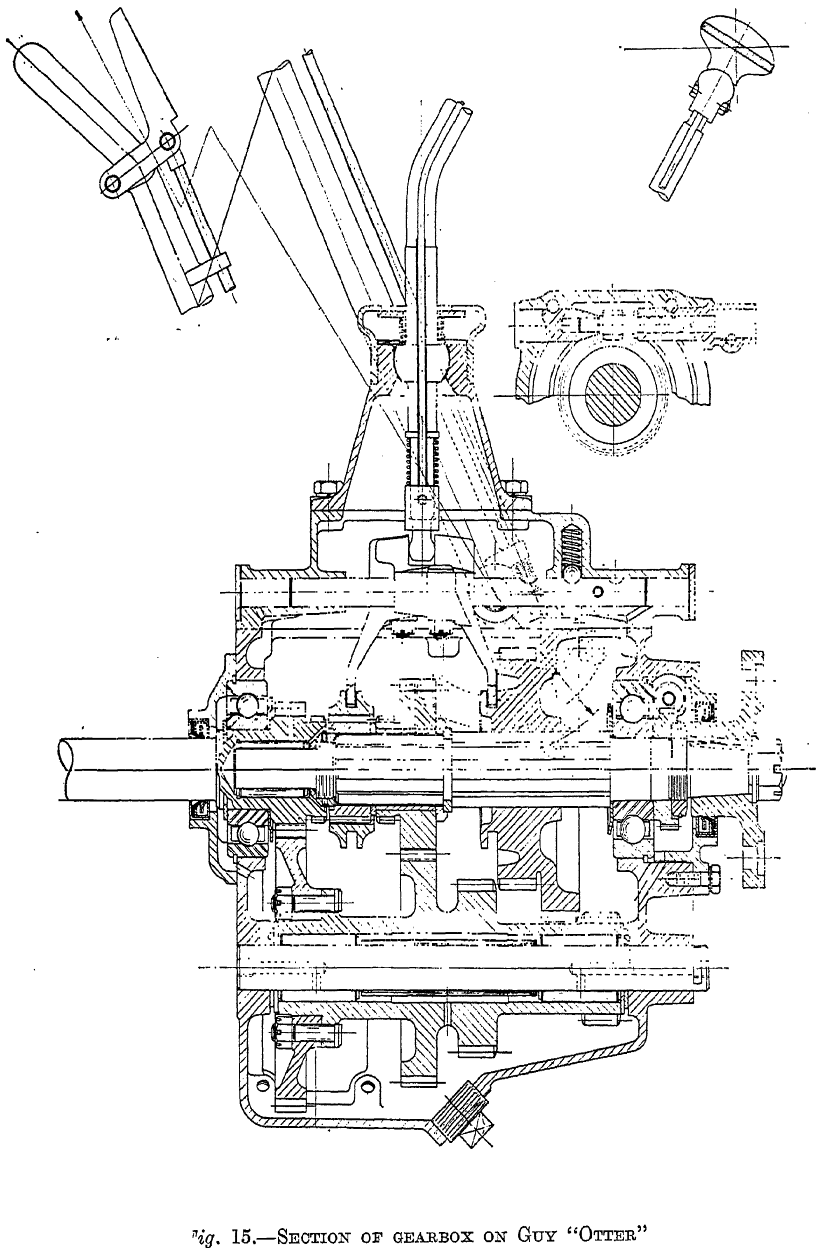


Fig. 15.—Section of gearbox on Guy "Otter"

front end cover. Shims are fitted between the front and rear covers of the gearbox, and these must be returned exactly as originally fitted, as they do not take up wear but serve to ensure the correct locking up of the ball races in the casing.

Clutch Adjustment

This is by means of a wingnut which is below the clutch-pedal shaft and is accessible through the cab floor. As the clutch wears it will be noted that the free travel of the clutch pedal increases. When the clutch is properly adjusted, the correct free travel of the pedal is $\frac{9}{16}$-in, measured at the pedal pad. To adjust clutch, turn wingnut in a clockwise direction when facing the front of the chassis.

REPAIR AND MAINTENANCE OF THE AUSTIN 10-H.P. ENGINE

By W. T. MEAD, M.I.M.T.

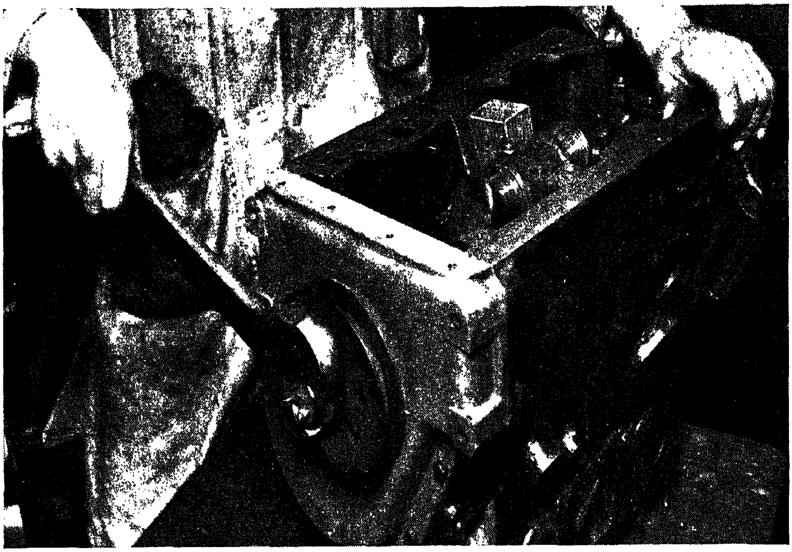


Fig. 1.—DISMANTLING THE ENGINE

Wedging the crankshaft with a block of wood whilst starting dog nut is removed.

BEFORE carrying out any repairs to the engine, test it; even though one has a specific order for certain work the test should still be carried out. For instance, the owner may give instructions for new pistons or rings to be fitted, and at the completion of the work, during the test, the main bearings may be found to be faulty, necessitating the complete stripping out of the engine and duplication of the work already done.

Having carried out the test, a decision can be made as to whether the engine should be completely dismantled for a thorough overhaul or only the head, sump, pistons, and connecting rods removed. The deciding factor is the condition of the main bearings. If they are in good condition, any other work necessary can be carried out with the engine in the frame—even to the extent of reboring, now that efficient suction plants can be obtained for carrying away the waste metal. Engineers' opinions differ as to the extent of wear necessitating reboring, but my own experi-

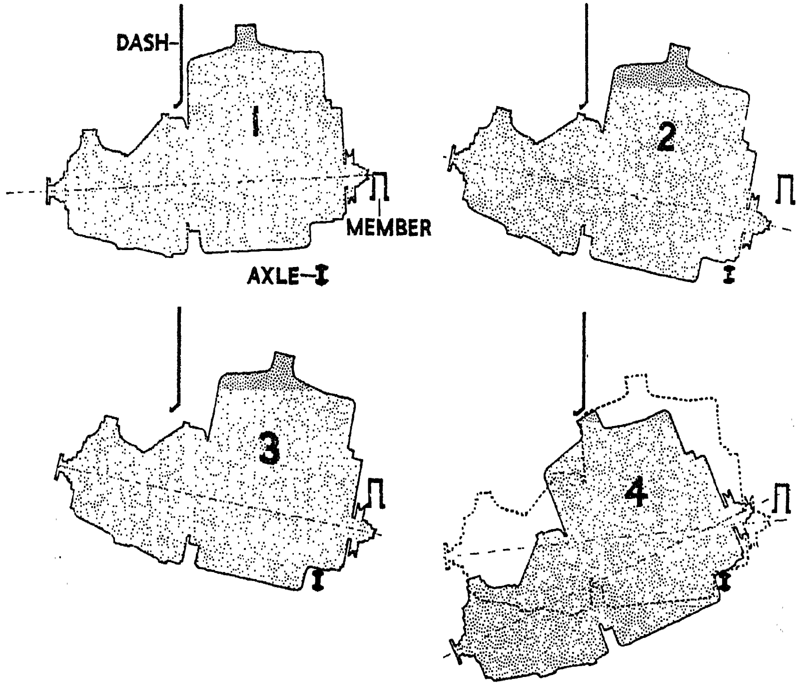


Fig. 2.—REMOVAL OF THE RUBBER-MOUNTED "TEN" ENGINE INVOLVES CAREFUL MANŒUVRING

1. Normal mounted position. 2. Lower engine and raise gearbox end of unit. 3. Push engine forward and lower until front of sump rests on axle. 4. Continue to lower, allowing the engine to pivot on axle.

ence is that Wellworthy rings will deal adequately with piston slap or over-oiling up to ·007-in. taper wear, and any amount of ovalisation likely to be met with.

We will, however, deal first with the removal and overhaul of the engine.

Removal of the Engine

The engine is withdrawn from below the chassis, and the procedure is as follows:

Remove the cushions and push back the front seats, or remove the seats entirely if preferred. Remove the nearside battery-box cover and disconnect the battery earth wire. Remove the front floor covering. Remove the bonnet, by taking off the rear hinge bracket; the bonnet will move backwards and up when the hinge is clear of the front bracket. Be careful not to scratch the paint on the scuttle when doing this.

Now drain out the water. Take off the clutch pedal after loosening

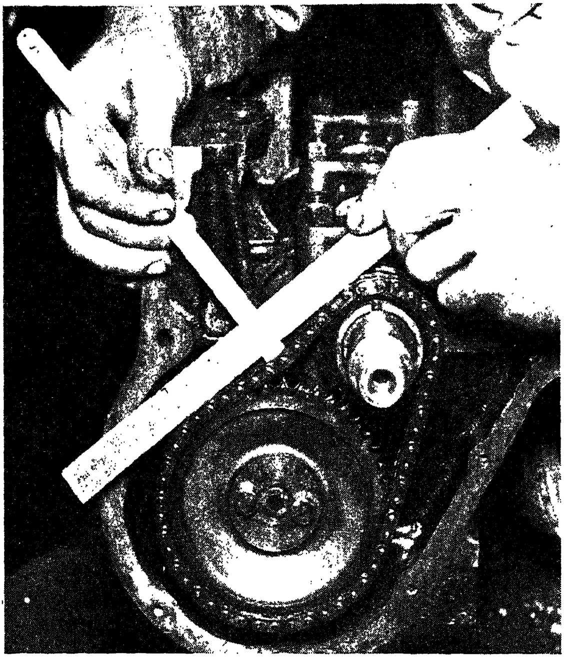


Fig. 3.—CHECKING THE WEAR ON THE TIMING CHAIN

the clamping bolt. Unscrew the change-speed knob, then take out the ten screws of the draught and fume excluder; the excluder will now pull off the top of the box and up over the lever.

Disconnect and take away the dynamo and belt, top water hose, the distributor cap and wires. Take out No. 4 sparking plug. Then the two setscrews holding the oil-filler tube, and remove it. Remove the three setscrews with fibre washers holding the water inlet to crankcase. Disconnect the oil pipe from the crankcase. Take off the air-cleaner from the carburettor, disconnecting the petrol pipes, the throttle control and strangler, and remove the carburettor. Take off the four brass nuts holding the exhaust pipe to the manifold. Disconnect the flexible petrol pipe from tank to pump. Disconnect the earth and starter wires. Detach the speedometer drive from the gearbox. Remove the bolts connecting the front universal joint to the third-motion shaft flange.

Before starting on the engine mountings take the weight of the engine on tackle, fixing the sling around the engine in line with the petrol pump. Remove the nuts of the front mounting bolts. If the bolts are tight they should be levered out. Remove the rear gearbox mounting. Unscrew the lever from the top of the box. It is necessary to remove the nearside accelerator-shaft bracket and raise the shaft until it rests on the dipswitch, so that the engine clears during removal; also remove the nearside engine suspension bracket to allow clearance.

Use care in removing the engine, and proceed in the following manner, with assistance: Keep the gearbox end of the engine well up and lower the front end of the engine until the starter dog is just below the front member. Draw the engine forward and lower until the front end of the sump rests on the front axle. Now lower the rear end, allowing the front



Fig. 4.—TESTING FOR SLACKNESS OF GUDGEON PIN IN CONNECTING ROD

end to pivot on the axle and keeping it as far forward as possible. In this manner the rear end of the cylinder head and the top of the water outlet will just miss the engine dash. When clear of the dash the engine can be moved back and lowered to the ground or down the pit (Fig. 2).

Dismantling the Engine

The engine having been removed from the chassis, proceed in the following order: Remove the gearbox from the engine. Remove, in order, the distributor, petrol pump, starter motor, cylinder head, valves, springs, and cups. The split-type cotters are standard on present-model engines.

Remove the sump and take off the oil pipes and oil pump. Knock up the locking plates, take off the big-end caps; they draw out from the opposite side to the camshaft. All parts are numbered except the connecting rods, and No. 1 starts at the front end of the engine. Take off the front engine brackets.

Place a small block of wood between a web of the crankshaft and the inside of the crankcase to prevent the crankshaft turning, and take off the starting dog nut (Fig. 1). A smart blow on a set-spanner will release it.

Checking Timing Chain Wear and Removing

Remove the front engine cover. Now check the timing chain for wear before removing it. Place a foot rule edgeways along the top of the chain from the crankshaft to the camshaft gears (Fig. 3). Press the slack away from the rule and measure the distance; if more than $\frac{1}{4}$ in., fit a new one; it would still run for a long time but it would be noisy at low speeds. To remove the chain, which is the endless type, take out the two setscrews holding the camshaft gear to the camshaft. Now draw off the crankshaft gear with a claw-drawer: take care not to bruise the teeth

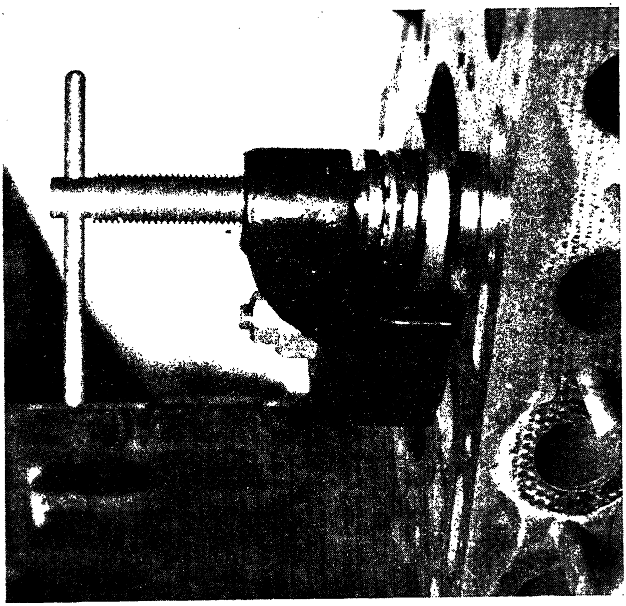


Fig. 6.—PRESSING IN THE VALVE-SEATING INSERT WITH THE BUMA TOOL

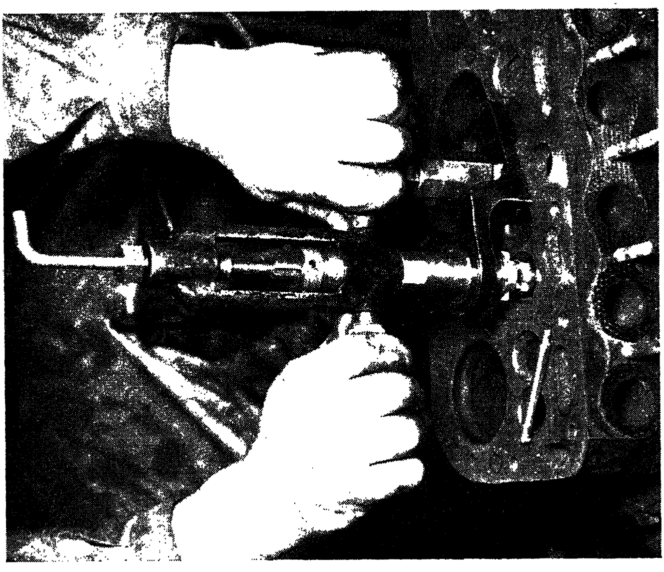


Fig. 5.—USING THE BUMA VALVE-SEATING INSERT CUTTER

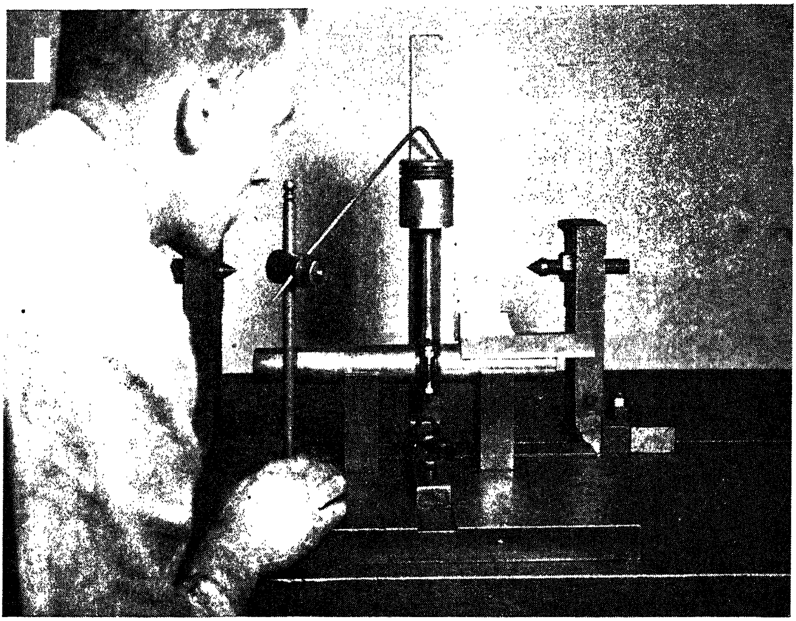


Fig. 7.—TWO WAYS OF CHECKING PISTON ALIGNMENT
Across the top with a scribing block and up the side with a square.

Dismantling Flywheel Assembly

Next, from the rear end of the engine take out the six setscrews that hold the flywheel cover to the flywheel. The cover will then come away, bringing the clutch assembly with it. Take out the three screws holding the flywheel-bearing cover which acts also as a locking-plate for the flywheel bolts, of which there are six; knock the bolts out, they will each in turn pass the rear bearing after removal of the cap. The flywheel can now be gently levered off. A drift can be used against the back of it through the starter hole in the clutch housing if necessary. When levering off the flywheel remember the housing is aluminium, and do not use too much force.

Removing Crankshaft and Camshaft

Remove the crankcase rear cover. Take out the setscrews holding the aluminium flywheel housing to the crankcase. When the housing is off, carefully remove the crankshaft oil spinner. Take off the main-bearing caps and the crankshaft will lift out. Now remove the tappets and pull out the camshaft from the front. Thoroughly clean all parts.

Examining for Wear

Take off the piston rings and disconnect the connecting rods from the pistons. The gudgeon pins float in the pistons and are locked in the

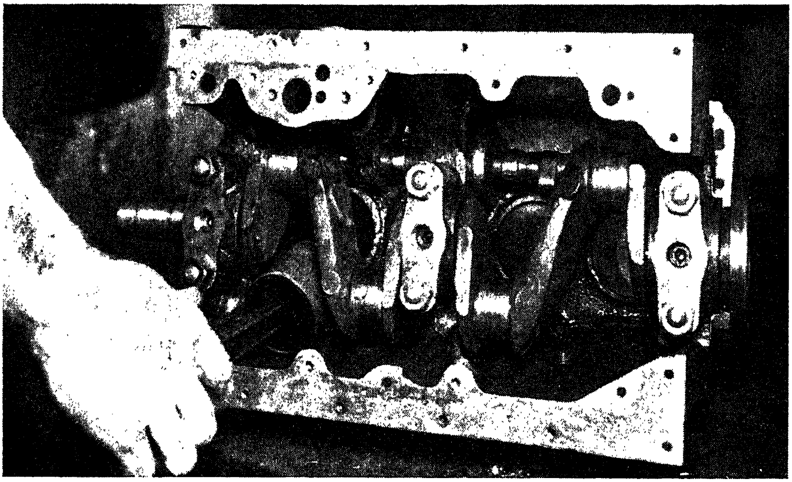
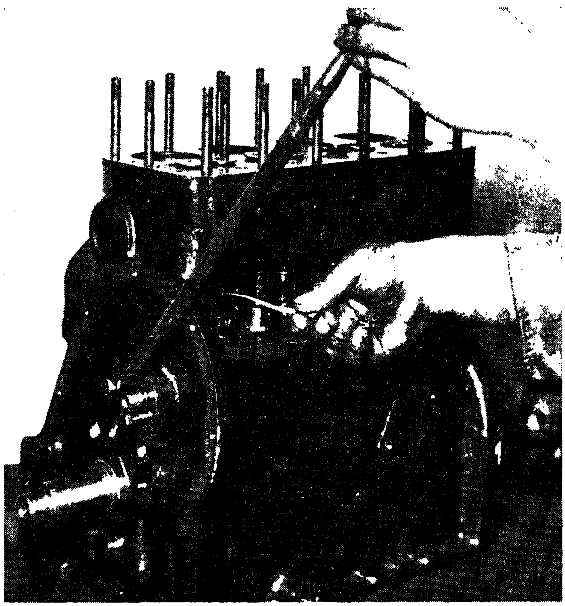


Fig. 8.—REFITTING CONNECTING ROD AND PISTON

Passing the piston between the crankcase and crankshaft on the opposite side to the camshaft.

Fig. 9 (*right*).—SETTING THE VALVE TIMING

Place the lever between the two screws at the end of the camshaft and revolve the camshaft until No. 1 inlet valve starts to open. This can be checked with a ·002-in. feeler, as shown. Now turn the flywheel until the timing marks on it register T.D.C. The timing wheels and chain may now be placed in position.



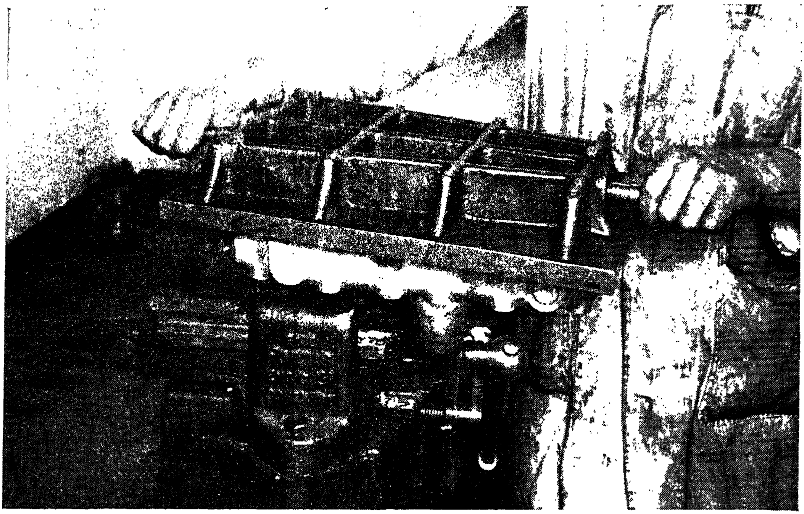


Fig. 10.—TESTING THE ALUMINIUM CYLINDER HEAD WITH A SURFACE-PLATE

connecting rods by $\frac{5}{16}$-in. B.S.F. setscrews. Knock up the lock-washers under the setscrews, and use a good-fitting hard-jawed set-spanner to remove the screws. Take care not to let the spanner slip and chew up the heads of the screws. When the screws are out the pins will push out. Examine the pins and make sure they have not moved in the connecting rods. If there are any doubts about it, put the pins into the rods, lock them with the setscrews, hold the pins endwise in the vice and make sure there is not the slightest movement of the rods on the pins (Fig. 4). If a pin will not lock in the rod the rod will have to be renewed.

Checking Cylinder Bores and Pistons

Now check up the cylinder bores and pistons. The most efficient way of checking the bores is with a micrometer or micrometer bore gauge. The pistons fitted are a special low-expansion aluminium alloy and are anodised after machining; they are slightly oval in shape, the greater diameter being at right angles to the gudgeon pins, the clearance here between the skirt of the piston and the cylinder walls being ·003 in. It will be seen that little wear takes place on the pistons, any found being in the bores of the cylinders. The manufacturers supply three sizes of pistons for this model: standard, $\frac{1}{64}$ in. oversize, and $\frac{1}{32}$ in. oversize. To each of these sizes there are three grades of pistons; they are marked thus: 1, 2, 3. No. 1 is the exact size of bore; No. 2, ·0005 in. oversize; No. 3, ·001 in. oversize. It will be seen, therefore, that some scope is allowed for piston selection and fitting. If no reboring

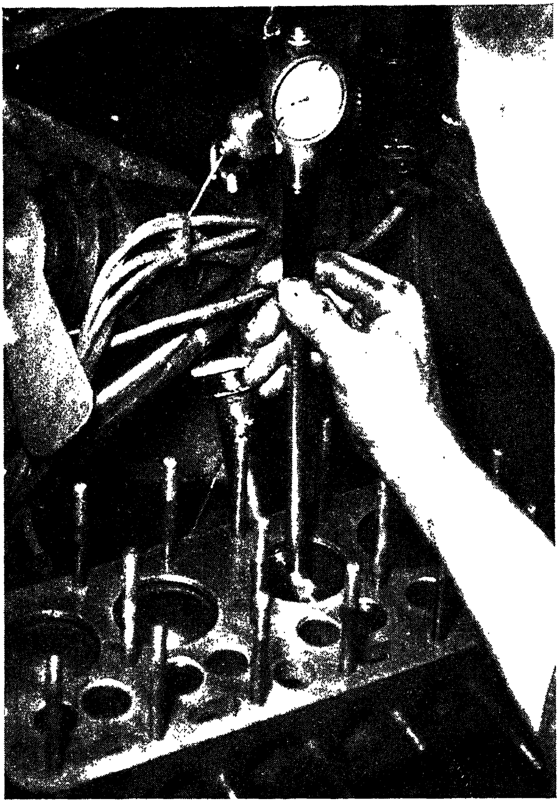


Fig. 11.—USING THE MERCER BORE GAUGE

plant is available, the manufacturers have an exchange scheme for rebored blocks. Although Wellworthy rings would make an efficient repair in the case of wear up to ·007–·008 in. if the engine was not dismantled, it is advisable in the case of a complete overhaul to rebore if the wear is more than ·003 in. It is, of course, very doubtful if the engine would have been dismantled unless the wear was more than this.

The Valve Gear

Carry out a careful examination of the valve guides and seats. If new guides are necessary, the old ones can be driven out from the top and new ones driven in from the same direction. The distance from the top of the guide to the top of the cylinder block should be $1\frac{1}{8}$ in. If new guides are fitted, the seatings should be recut. It should always be borne in mind that as little metal as possible be cut from the block when using a valve-seating cutter. Although it is very unusual to find a seating so wide or burnt as to make it unserviceable, it is possible to machine out the block and fit an insert in such circumstances.

Fitting Valve-seat Inserts

Figs. 5 and 6 show a Buma cutter being used. This is a universal tool which cuts the block and presses in the insert. It is advisable to fit a new valve guide when fitting an insert.

When the seatings have been reconditioned as necessary, examine and test the valves—in a valve-grinding machine, if possible, or else on a

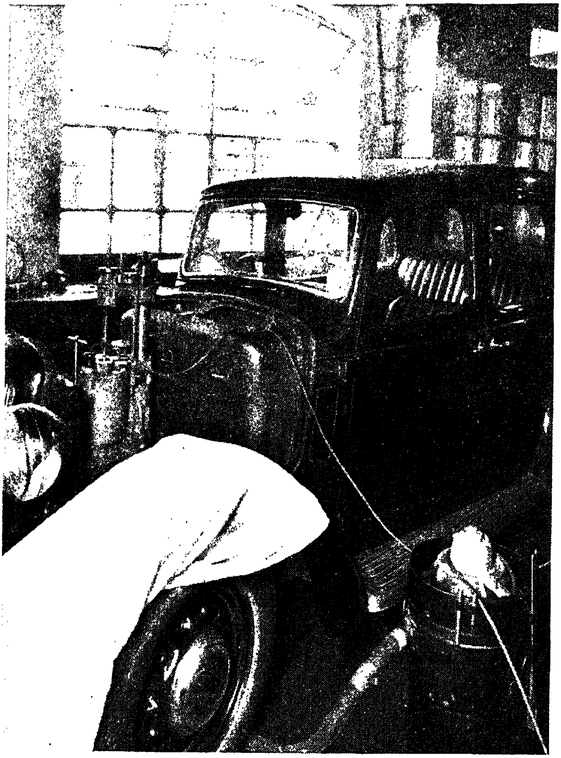


Fig. 12 (*left*).—REBORING THE ENGINE IN POSITION

This picture shows the Van Norman borer and Buma suction plant being used.

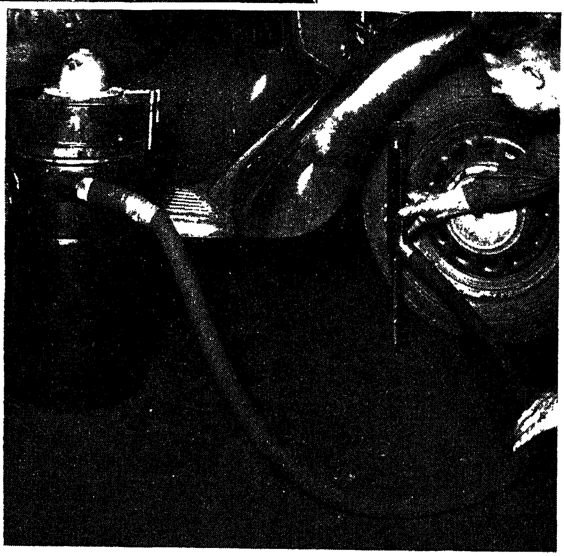


Fig. 13 (*right*).—THE BUMA SUCTION PLANT

Showing the rubber cup for fitting at the bottom of the cylinder bore on an adjustable leg. Rubber cups of varying sizes are supplied.

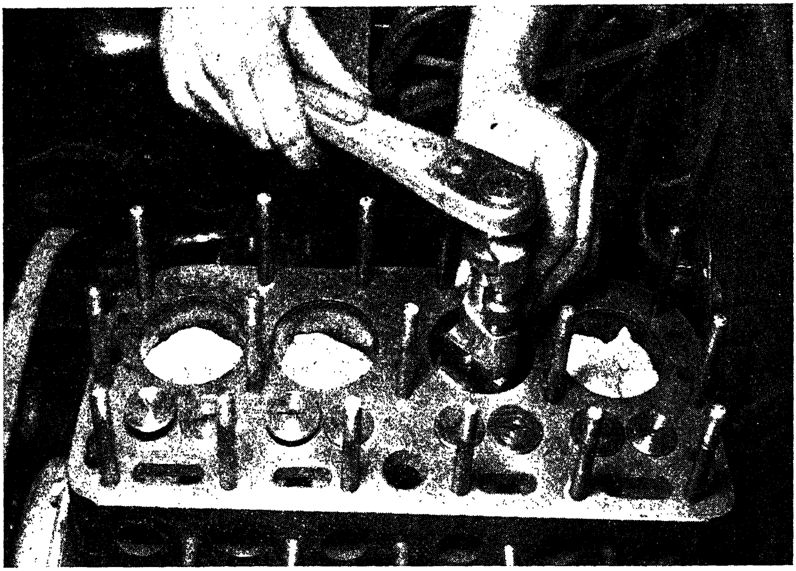


Fig. 14.—USING THE RIDGE-REMOVING TOOL

lathe. If any of the exhaust-valve seatings are badly distorted, replace the valves ; they are not very expensive, and there is a risk that even if trued up they may go again. Check all stems and if worn renew them. The valve should seat about half-way down the chamfer. If the seating takes place too near the outer edge the valve will pocket and burn. Finally grind them all in very carefully.

Inspect all tappets and renew any which have flats worn on the radius ; dress the heads of the tappet screws or renew them if necessary. Check the valve springs ; if weak replace them.

Examine the camshaft and oil-pump gear. Check the oil pump, the only part needing attention should be the bottom face. This will probably be recessed and need facing. The camshaft runs in bi-metal bearings and no excessive wear is likely to be found here. If new ones are needed it is a job for the manufacturers, because they are all different sizes and a special reamer is necessary.

The Crankshaft and Bearings

The crankshaft and bearings should now be examined. High-precision type bi-metal bearings are fitted, they need replacing only if slack, and on no account should any attempt be made to scrape them or file the caps. There should be ·002-in. clearance between the bearing and the journal. If the journal is so badly worn that a new standard bearing is too slack, the shaft should be ground down, and special under-

size bearings fitted. These particulars apply also to the connecting-rod bearings. The thrust on the crankshaft is taken on bronze washers fitted to No. 3 bearing. The shaft should have ·003-in. end float.

Fitting the Pistons

Having fitted the crankshaft to the crankcase, fit up the new pistons to the connecting-rods. Take care to tighten the gudgeon pin in the connecting rod, but do not forget the screw is only $\frac{5}{16}$ in. B.S.F., and do not shear the head. Now line up the pistons to the connecting rods ; there are several popular alignment tools on the market now, or one made as shown in Fig. 7 will do the job. This is a particular operation, to which sufficient care is not always shown. It has a big bearing on bore wear, oil consumption, etc.

Piston rings should have a gap of ·006 in. The present type of piston has three rings above the gudgeon pin, the bottom being a slotted type used as a scraper ring.

When refitting the connecting rods and pistons, pass them between the crankshaft and crankcase on the opposite side to the camshaft (Fig. 8).

Replacing Camshaft

Having fitted the pistons and connecting rods, replace the camshaft. Inspect the camshaft and crankshaft gears, and if worn replace them. If new ones are fitted make sure they are in line, they can be lined up by fitting shims behind the crankshaft pinion. The camshaft gear fits with the dished side to the front cover.

Flywheel Housing

Now fit the aluminium flywheel housing with a new brown-paper washer between it and the crankcase. Do not make the mistake of fitting the sump before doing this, or the result will be an oil leak.

Worn Starter Ring

Before refitting the flywheel examine the starter teeth ; if they are worn, the old starter ring should be machined off and a new one obtained. This should be heated to a temperature of 200–250° Centigrade, in an oil bath or on a steel plate over a gas-ring. At this temperature it should be placed on the machined portion of the flywheel, taking care the teeth are the right way, with the lead on the teeth towards the starter-motor position. The manufacturers will exchange the old one for one with a new ring.

Fitting Flywheel

Before fitting the flywheel make sure the oil spinner is running true on the end of the crankshaft and fit a new washer behind the crank-

shaft cover. Fit the flywheel with the timing marks corresponding to the crankshaft; use a new brown-paper washer between it and the crankshaft. Now fit the valve tappets, then the valves and springs.

Timing the Engine

To time the engine, take off the camshaft gear now it is lined up, and screw the two holding screws back into the shaft. Adjust the tappet clearance on No. 1 inlet valve ·003 in. Now with a lever between the screws at the end of the camshaft revolve it until No. 1 inlet valve starts to open. This can be checked with a ·002-in. feeler (Fig. 9). Now turn the flywheel until the timing marks 1–4 are T.D.C. Now take out the screws from the camshaft end and fit the camshaft gear and timing chain. Now turn back the flywheel until the timing marks are $\frac{3}{4}$ in. B.T.D.C. Then insert the distributor with the pointer in the middle of the scale and the points about to break with the rotor opposite No. 4 electrode on the distributor cap. Before fitting the distributor make sure the contact points are in good condition and the automatic advance and retard working freely. Check the springs of the balance-weights, and if they appear weak renew them. The final fine-ignition setting should be done on the road test. Now fit the oil pump and the oil service pipes.

Fitting the Aluminium Head

Before fitting the cylinder head check it on a surface-plate and if there is any distortion dress it up (Fig. 10). Take care to fit the correct type of gasket to correspond with the water slots. Take particular care to pull the head down evenly, starting from the middle, then the opposite corners, and working back to the middle again (this is more important with an aluminium head than with a cast-iron one).

Check the sparking plugs and fit a new set if the electrodes are burnt.

Replacing Timing Cover

When fitting the front timing cover make sure the felt washer which fits over the fan pulley is in good order; it is best to place the pulley in the front cover and refit them both together. When fitting this see that the thrust button at the end of the camshaft allows ·003 in. end float. This can be arranged with shims.

After fitting the front cover put up the sump. Test the position of the starting dog relative to the starting handle and compression before the engine goes into the chassis. Make sure the engine-bearer rubbers are in good order in the chassis.

The clutch should, of course, receive attention if necessary before assembling, and instructions for this have already appeared in an earlier part of this publication.

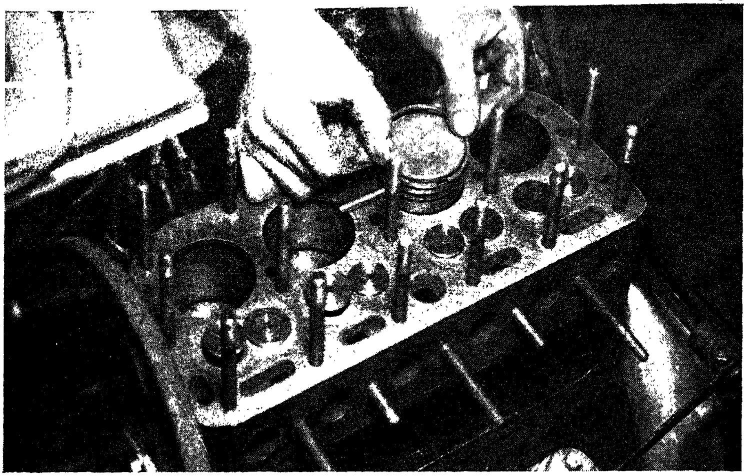


Fig. 15.—Fitting Wellworthy rings

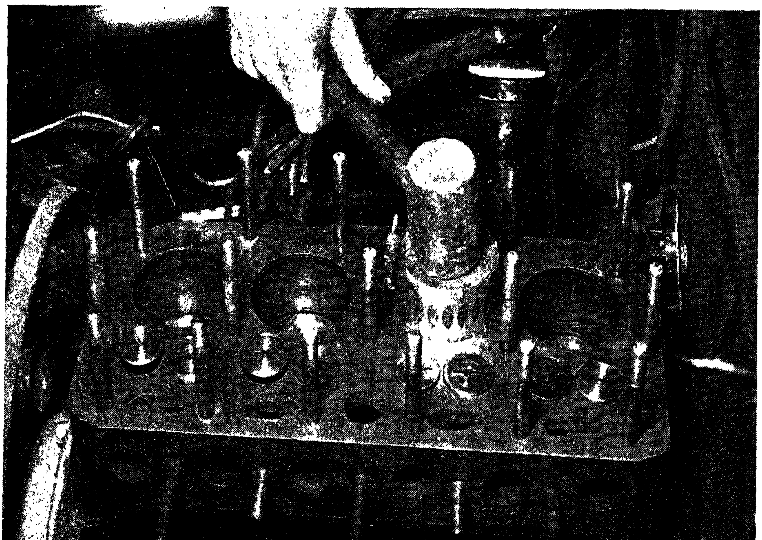


Fig. 16.—Fitting Wellworthy rings

Driving the piston fitted with Wellworthy rings out of the piston-cuff into

Running In

It is advisable to run the engine on a stand or test-bench if possible. If not, assemble the clutch and gearbox to the engine, refit it into the frame and mount up the starter, dynamo, petrol pump, exhaust manifold, distributor cap, sparking plugs, ignition wires, exhaust drop pipe, and controls. Do not adjust the dynamo belt too tightly or strain will be put on the armature bearings; on the other hand, too slack a belt will cause vibration. Do not fit up the cardan shaft until the engine has been run in. The final tappet adjustment should be ·004 in. hot.

It is well to run the engine for the first 500 miles with colloidal graphite in the oil. Mix the compound with the engine oil before putting it in the engine, run the engine for about four hours, gradually increasing the revs. from about 800 to 1,500. At the end of that period it should be possible to give it a short burst of higher revs. If acting normally, keeping as free as can be expected and with no undue noises, the engine can be put into the chassis or coupled up to the propeller shaft if already in.

Reboring the Engine in Position

Assuming the test report has shown the main bearings to be in good condition, but the pistons and the big ends to need attention, it is not necessary for the engine to be removed. Take off the head and sump, then the oil rail. Remove the connecting rods and pistons from below and check the bores. Fig. 11 shows a Mercer bore gauge in use for this operation. If ·008 in. or more wear has taken place, rebore the block. This should not be done unless precaution is taken to collect all waste metal as it is cut from the bores.

Figs. 12 and 13 show a Van Norman reboring machine being used in conjunction with a Buma suction plant. By the use of machines such as these all the old objections to reboring in position are overcome, and the use of them with care and precision results in perfectly cut bores in the minimum of time. Bores can be cut as accurately as the operator can use his micrometer. It is always well, though, to cut to the middle grade of piston, namely 2. Then, if the human element enters into it and there is an error of half a thou. up or down, either a 1- or 3-grade piston can be used. It will be necessary, of course, to remove the valves and give them any attention as described previously. All the studs must be taken out, and for this use a stud box or chuck-type stud remover, and not footprints. Clean up the top of the block very carefully for assembling the boring bar. The radiator block must be removed and the two bottom nuts of the rear bearer. Place a jack under the flywheel housing and raise the engine as far as possible. It will not come up very much, but just enough for the bar to clear the standing dash. When the bores are finished refit the studs, having renewed any upon which the threads appear to have stretched.

Before fitting the connecting rods and pistons renew any bearings necessary, check the gudgeon pins, and line up the pistons.

Fitting Wellworthy Piston Rings

If the bore is found to be worn not more than ·008 in., Wellworthy piston rings should be fitted. New compression and oil-scraper rings should, of course, be used at the same time. Under the conditions mentioned, Wellworthy rings are an infallible cure if fitted correctly. The instructions for machining the pistons and fitting the rings must be closely followed. The depth and width of the groove are most important. The drilling of the two relief holes in the bottom of the grooves on each piston must not be forgotten.

It is necessary to remove the ridge at the top of the bores. A scraper can be used for this but it is a slow method, a section might be missed. It is better to use a ridge-removing tool, as shown in Fig. **14.**

Fitting the Pistons

The rings having been fitted they should be removed from the pistons and each, with the connecting rod fitted, should be passed into the engine from below between the crankshaft and crankcase on the opposite side to the camshaft. Pass it right through until the gudgeon pin is clear of the top of the block ; pass a small bar through the bore of the gudgeon pin. This bar should be long enough to prevent the piston dropping back through the cylinder block (Fig. 15). Now the rings should be fitted. Here again the instructions supplied with the rings should be exactly followed. The position of the slot relative to the gudgeon pin is important. For inserting the piston a special cuff supplied by the makers should be used. When the cuff is fitted the piston should be given a smart blow with a lead or hide hammer to drive it into the bore (Fig. 16).

SPECIAL POINTS TO BE WATCHED WHEN REPAIRING TRIUMPH ENGINES

By H. W. ALLISON

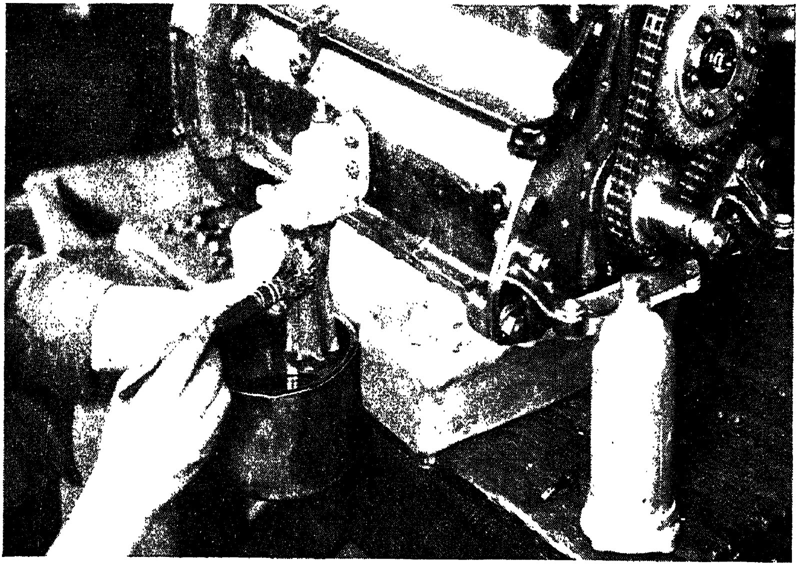


Fig. 1.—CLEANING OIL FILTER ELEMENT (DOLOMITE AND VITESSE ENGINES)
Note method of washing the element in position.

DOLOMITE AND VITESSE ENGINES

The Engine

THE Triumph Dolomite and Vitesse engine has undergone little alteration since its inception in 1936, and such small modifications as have been found desirable have been effected without losing sight of the advantages of interchangeability. This being the case, the matter of maintenance and repair is simplified, and it may be taken that the following notes are applicable to the complete Dolomite and Vitesse ranges.

Both four- and six-cylinder engines are designed on similar lines, and as orthodox principles have been followed only a brief description will be necessary.

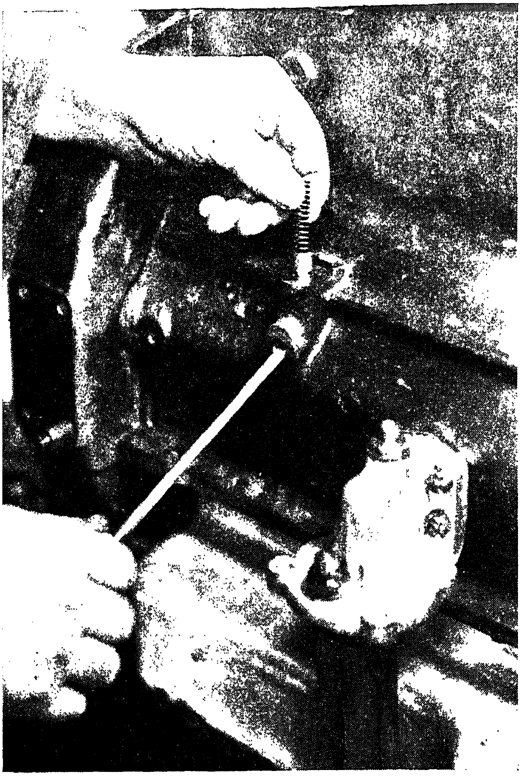


Fig. 2.—REMOVING OIL RELEASE VALVE
Any sudden drop in pressure is most likely to be caused by dirt lodging under valve. The illustration shows the plunger being pushed out with the end of a screwdriver.

General Description

The capacities of the two four-cylinder models ($1\frac{1}{2}$-litre and 14/60 types) are 1,496 c.c. and 1,767 c.c. respectively, and that of the 2-litre model, 1,991 c.c. A stroke of 100 mm. is common to all three engines, and the respective bore sizes are 69, 75, and 65 mm. The R.A.C. ratings are 11·81 h.p., 13·95 h.p., and 15·72 h.p., and the brake horse-powers developed are 55, 59, and 68. The recently introduced Roadster models develop $62\frac{1}{2}$ b.h.p. (14/65 models) and 72 b.h.p. (2-litre model): these engines are specially tuned, and the 2-litre Roadster, like the 2-litre Royal Saloon, is equipped with three S.U. carburettors.

Overhead valves are rocker and push rod operated through mushroom (on current models, piston-shape) tappets, and double valve springs are fitted throughout.

The timing gear is duplex chain-driven, and the dynamo, water pump, and fan are driven by a common belt. The dynamo is mounted on a bracket attached to the offside of the crankcase and pivots through a lower slotted bracket. The belt is adjustable on both the dynamo bracket and the eccentrically mounted fan spindle.

Crankshafts are fully balanced, the four-cylinder type being carried in three bearings and the six-cylinder type in four. RR53 Hiduminium alloy split-skirt pistons are fitted to all models.

MAINTENANCE, OVERHAUL, AND MINOR REPAIRS

Dealing first of all with the more common maintenance overhauls and minor repairs, it is not essential to remove the oil-filter element in

order to clean it. The filter assembly is fitted to the offside of the crankcase, and when the body has been removed, after withdrawing the four bolts holding it to the cap, the element may be washed in position, holding a small tin of paraffin under it and using a fairly stiff brush. Incidentally, the filter incorporates a "blow-off" valve which comes into operation if the filter element is allowed to become choked. The oil thus by-passed is of course unfiltered, however, and for this reason the filter element should be cleaned at least once every 5,000 miles.

Fitting Replacement Fan Belt

The fitting of a replacement fan belt necessitates the moving forward of the starting-handle shaft, in order to provide sufficient clearance between the crankshaft-fan pulley and the end of the starting shaft. To do this, the claw which is bolted through the shaft must be removed. Then slacken the fan-pulley spindle locking bolt, and release the tension on the belt by rotating the spindle to its lowest point. The new belt may be sprung over the edge of the dynamo pulley, after it has been fitted to the other three pulleys, and adjusted on the fan spindle and/or dynamo bracket. In some cases, it may be found necessary to move the radiator forward a little, and this is easily accomplished by taking out the bolts which attach the radiator block to the chassis frame front cross-member, and to the grille. It will then be found possible to push the radiator forward sufficiently far to give the necessary clearance between it and the fan pulley.

Fitting Cylinder-head Gasket

It is important to note that when the cylinder head is being replaced (after a decarbonising operation, for example), the gasket must be refitted correctly, otherwise water circulation will be stopped. All cylinder-head gaskets supplied by the engine manufacturers are marked by painting, and it is the painted side which must be uppermost.

Grinding-in Valves

Tulip valves are fitted to the more recent productions, and the use of a moulded rubber pad on the end of the reciprocating tool will provide sufficient grip on the valve head, if the surfaces of both pad and valve head are kept perfectly dry, to enable the operator to carry out the usual grinding-in operation.

Mounting Distributor

It is useful to remember that three different methods of mounting the distributor have been used, the original one being vertical, the second one horizontal, and the current one at 45°. The vertical is on the offside of the engine and is driven through a transverse shaft off the camshaft. The later types are fitted to the nearside of the engine, and

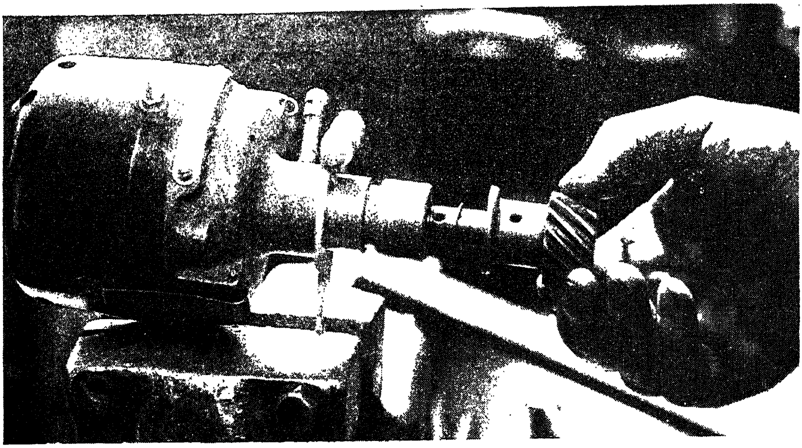


Fig. 3.—FITTING FIBRE WASHER TO TAKE UP END PLAY IN DISTRIBUTOR SPINDLE

are directly driven through a skew gear, the cross-shaft being dispensed with.

The horizontally mounted distributor is more prone to develop gear noise than the other types, due to the fact that the bush in which the driving spindle is housed eventually wears. The remedy is to renew this bush, but in addition a slightly oversize spiral gear can be obtained, and the fitting of one of these has an additional quietening effect. The gear wheel is pegged to the distributor driving shaft and its renewal is a simple matter. While fitting a new wheel it is as well to check the development of end play by interposing a fibre washer between the base of the spindle bush and the gear.

Checking Pressure of Petrol Pump

A mechanically operated petrol pump now replaces the original electric type, and this is driven off the oil-pump shaft. It is unlikely that this will give any trouble, but if the consumption of petrol is excessive, or the carburettors are prone to flood, the pressure should be checked and if necessary reduced by the interposing of a washer between the pump-body flange and the crankcase. A pressure of 1½ lb. to 2 lb. per square inch is recommended, and in no circumstances should the higher figure be appreciably exceeded. A priming lever will be found beneath the pump body. A filter is fitted, and to obtain access to this it is necessary only to remove the upper dome.

MAJOR REPAIRS

Removing Pistons

Turning now to the major or less frequent type of repair, it may be noted that it is not possible to draw the pistons past the crankshaft,



Fig. 4.—REMOVING PETROL PUMP ADAPTER AND PLUNGER

nor are the bores sufficiently wide to permit of the withdrawal of the connecting rod and piston assemblies from the top of the engine. It is therefore necessary, when piston removal is required, to remove the sump and cylinder head, detach the connecting-rod caps, and push the connecting rods and pistons up the bores until the gudgeon pins are exposed. Following the removal of the circlips the pins may now be driven out, and the separations effected. The connecting rods are, of course, withdrawn between the crankshaft and case.

Checking Free Rotation of Camshaft

When rebuilding a completely dismantled engine, it is desirable to check the free rotation of the camshaft after the oil pump and distributor-drive assembly have been fitted, as slight distortion of the faces of pump body and base of crankcase can cause tightness (the pump being camshaft-driven). The misalignment which is causing this can be corrected by the use of a suitable packing between the respective faces.

Rectifying Valve Timing

The camshaft-chain wheel is bolted to a boss which is keyed to the camshaft, and if rectification of the valve timing becomes necessary this may be effected by slackening the four or six attachment-bolt nuts and tapping back the bolts, which operation makes it possible to rotate the camshaft independently of the wheel. An inspection plate is fitted to the timing cover, and removal of this renders the chain wheel accessible for adjustment. It will be noted that two of the inspection-cover attachment bolts are partly concealed by the crankshaft-fan pulley, and it may not be possible to withdraw these without first taking off the pulley.

To obviate the necessity for this, these two cover-bolt holes are slotted, and after the bolts have been slackened and the remainder taken

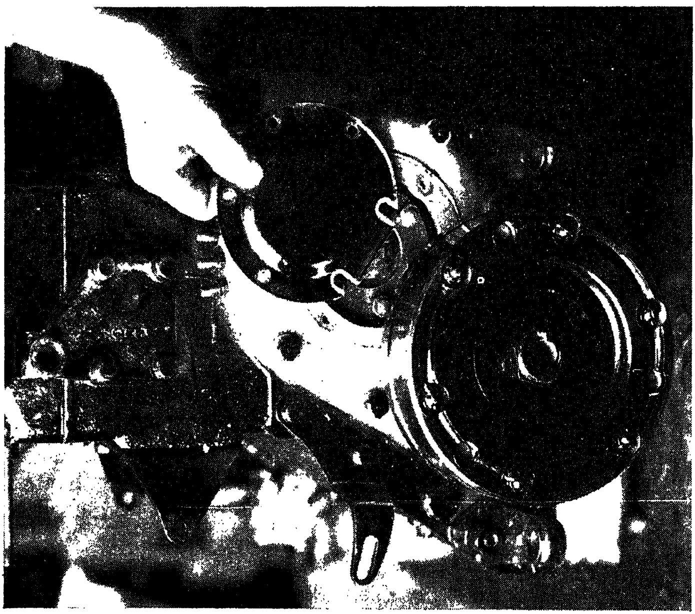


Fig. 5.—REMOVING CHAIN COVER INSPECTION PLATE

Note slots for easy removal.

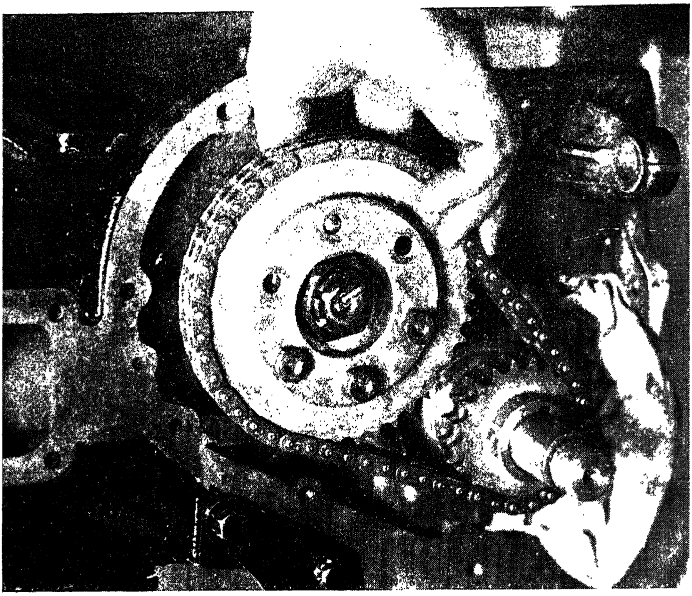


Fig. 6.—FITTING CAMSHAFT CHAIN WHEEL ATTACHMENT BOLTS

Note rag to stop bolts from falling into sump.

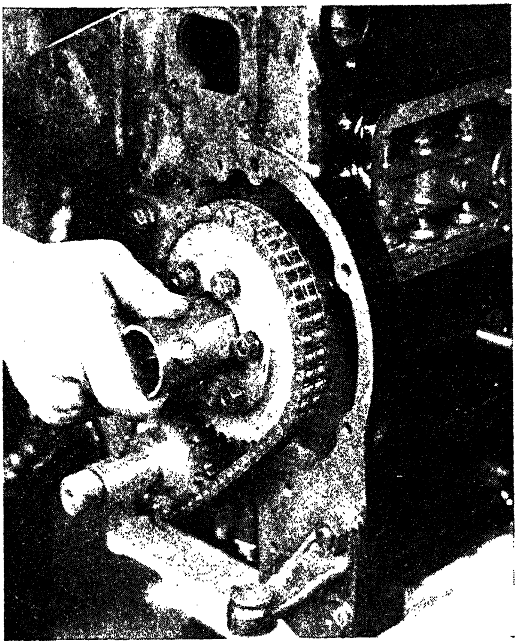


Fig. 7.—RECTIFYING VALVE TIMING
Showing wheel bolts slackened off.

out the cover can be slid off. The position of the piston can be determined by removing No. 1 sparking plug and inserting a piece of stiff wire in the hole, if a timing stick is not available.

Fitting Replacement Timing Chain

The fitting of a replacement timing chain necessitates the removal of the radiator and grille, and these items are best taken away *en bloc.* This is done by disconnecting the thermometer bulb from the thermostat (to which it is attached by a single nut), taking out the two thermostat cylinder head bolts, and the two water pump body crankcase bolts. Then disconnect the radiator tie-rod and remove the two bolts which hold the radiator block to the chassis frame front cross-member. Lastly, remove the eight bolts and nuts which attach the grille to the front wings.

The fan pulley is keyed to the crankshaft and is locked in position by the starting dog nut, which has a right-hand thread. Following the removal of these parts, the timing-cover bolts and subsequently the cover itself can be taken away. (The six-cylinder engine is equipped with a combined fan pulley and crankshaft vibration damper, which is described later.) The timing chain is of the endless type, and in order to remove it the crankshaft and camshaft chain wheels must come away also. The crankshaft chain wheel is keyed to the shaft, and the camshaft wheel is, as already described, bolted to a boss on the end of the camshaft.

To reassemble, fit the chain and the two wheels, and engage these with their respective shafts, but do not push them right home. The camshaft wheel attachment bolts must be fitted from behind the wheel, and this operation is simplified if as much space as possible is allowed between the crankcase and the back of the wheel for the introduction

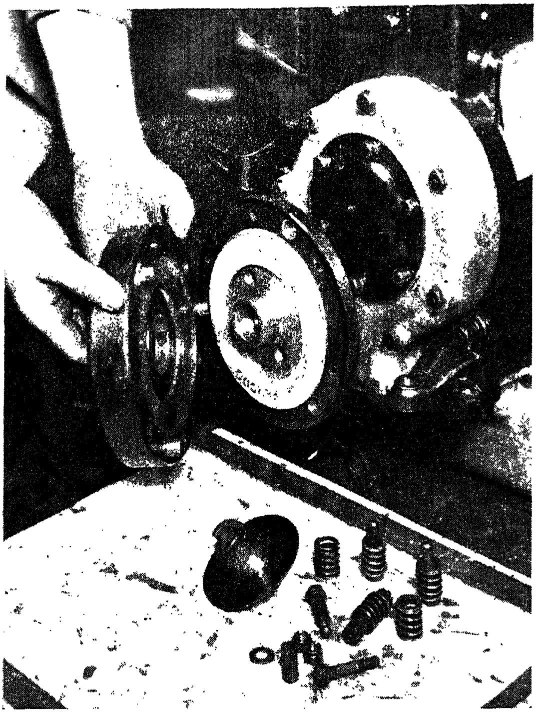


Fig. 8.—REMOVING FRICTION DISC OF CRANKSHAFT DAMPER

of the fingers holding each bolt. Only one bolt can be fitted at a time, and the wheel should be rotated so that each bolt hole is brought in turn to a point nearly opposite the crankshaft. Note that the bolt heads are chamfered and each chamfer must register against the conical face of the flange. The final tightening of the bolt nuts may be accomplished when all the bolts are in position.

Removing and Replacing Damper

To remove the damper, the starting dog nut must be taken off and the dust excluder, which fits behind it, will come away also. The six outer plate-attachment bolts, nuts, and springs are then taken out. The front plate and friction disc will now come away, exposing the centre plate, which is screwed on the crankshaft and is removed with the aid of a peg spanner. It must be noted that this centre plate has a left-hand thread. The rear plate, which runs, as does the front one, on the sleeve of the centre plate, will come off with it. When reassembling it may be necessary to interpose a shim between the back of the damper and the chain wheel to obviate fouling between it and the timing cover. Care should be taken to ensure that the bolt nuts are not over-tightened, or the functioning of the damper will be interfered with. It should be just possible to insert the split pins.

Main and Connecting-rod Bearings

Crankshaft end thrust is taken on the rear bearing in all cases, and an end clearance of ·002–·003 in. should be allowed on this bearing and on all connecting-rod bearings. White-metal bearings are used, the main bearings of the more recent productions being steel-backed. About

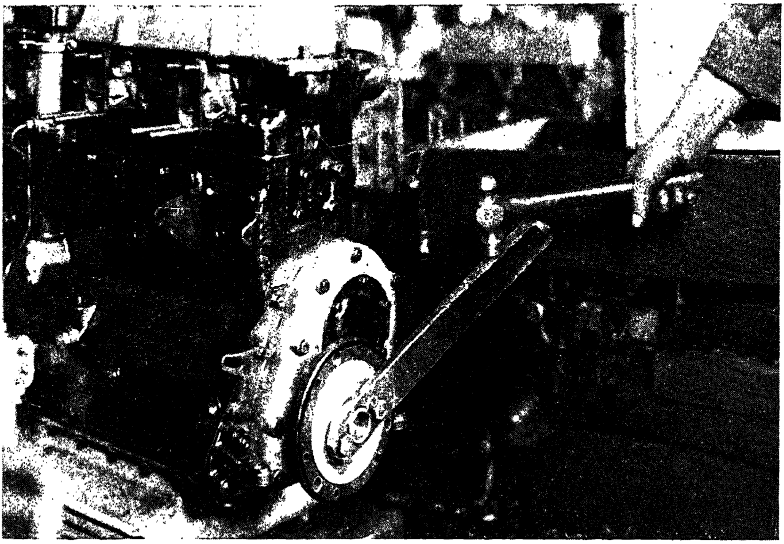
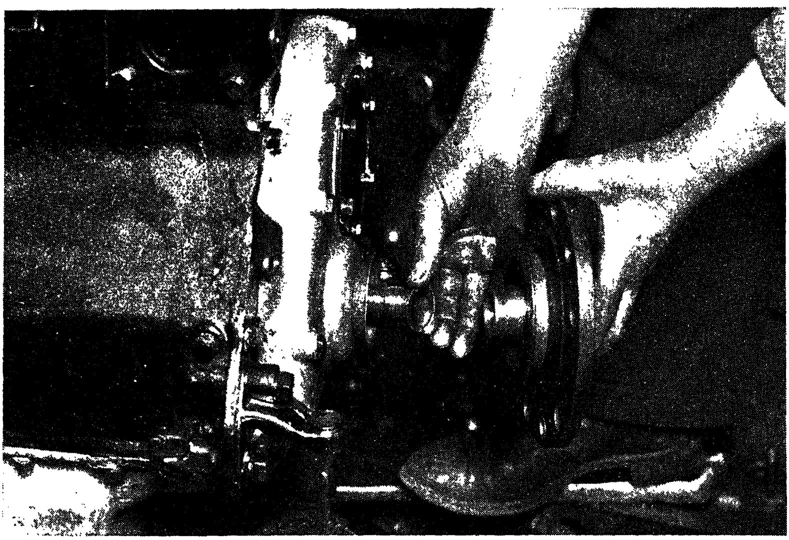


Fig. 9.—REMOVING CENTRE PLATE OF CRANKSHAFT DAMPER
This has a left-hand thread.



10.—FITTING SHIM BETWEEN REAR DAMPER PLATE AND TIMING COVER

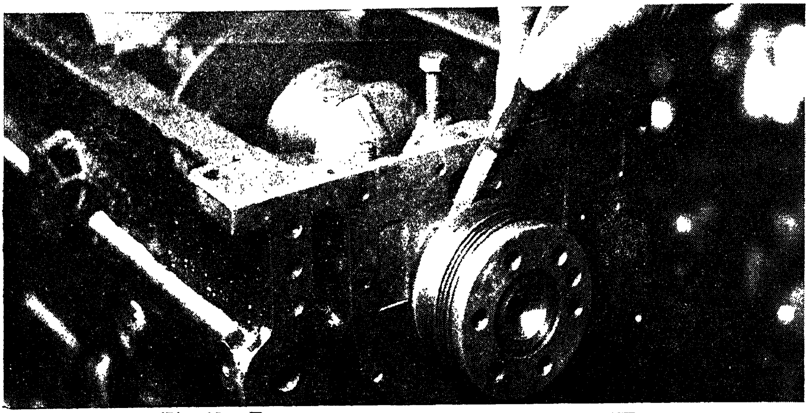


Fig. 11.—TESTING FOR THRUST BEARING CLEARANCE

·0015-in. bearing "nip" should be allowed when bedding in a new or reground crankshaft, and filing of the main bearing caps is permissible to obtain this. Correctly fitted connecting rods should spin on the crankshaft throws. The crankshaft oil return thread clearance should be ·003 in.

Oil Pump

Engine oil circulation is promoted by a filter-protected submerged gear-type pump, which draws oil from the sump and delivers it through a transverse pipe to a cast-in gallery feeding the main and camshaft bearings, and thence through the drilled crankshaft to the connecting-rod bearings. The cylinder walls and pistons are splash-lubricated by oil squeezed out of the connecting-rod bearings.

The oil pressure varies in accordance with the speed of the engine, but the indicator should maintain a reading of at least 30–40 lb. per square inch at road speeds in excess of 30 m.p.h.

There is little likelihood of anything going wrong with the pump, and any sudden drop in pressure is most likely to be caused by the lodging of a bit of dirt under the relief valve. This is the usual plunger-and-spring type and will be found on the offside of the crankcase, a little to the left of the filter. To dismantle this valve, take out the slotted screw and the spring, then remove the brass nut beneath the valve, after which the plunger may be pushed up with the end of a screwdriver. A point to note is that the oil pump cannot be removed until the petrol pump, adapter, and plunger have been taken away. This refers, of course, only to engines fitted with mechanically operated petrol pumps (Fig. 4).

Checking Lubrication of Overhead Valve Gears

It should be noted that the overhead valve and rocker gear is lubricated through the hollow mounting shaft, which is drilled for the

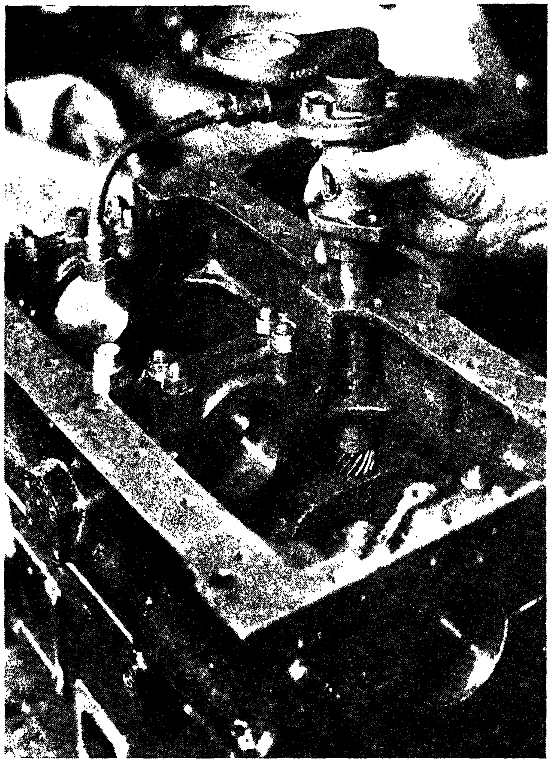


Fig. 12.—REMOVING THE OIL PUMP

purpose, and the feed pipe runs from the top of the filter to the rear end of the cylinder head. The adapter contains a small restrictor disc, and care should be taken not to omit to refit this if the pipe is disconnected for any reason. Should the rocker gear become dry, in which case it will develop noise, the feed pipe should be tested for obstruction, as should the 1/32-in. hole in the restrictor disc.

The hollow valve-rocker shaft is plugged at each end, and if attention to the relief valve fails to restore the pressure the remote possibility of one of these plugs having blown out should be investigated.

Fitting Replacement Set of Piston Rings

The rate of cylinder wear is very slow, and even when a considerable mileage has been covered the fitting of a replacement set of piston rings is usually sufficient to cure excessive consumption of oil.

A sudden increase in consumption is almost invariably due to the development of a leak between the cap and body of the oil filter, and the fitting of a new joint, using a good jointing compound, will cure this. Incidentally, it is advisable to wire the heads of the cover screws fitted to the early types. These cover screws have now been superseded by bolts and special shake-proof nuts. Ensure that these nuts are correctly refitted, i.e. with the fibre insert in contact with the filter cover.

Piston Clearances

Piston clearances, which are allowed for in the machining of the pistons are: Top land ·014 in.; 2nd land ·011 in.; and at the bottom

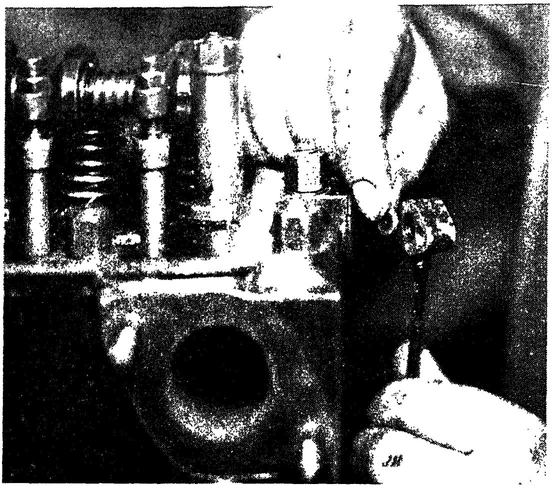


Fig. 13.—REFITTING VALVE ROCKER OIL FEED PIPE

Showing the restrictor disc. Care should be taken not to omit to refit this if the pipe is disconnected for any reason.

·002–·003 in. Two compression rings and one oil-control ring are fitted to each piston, and these should be given a gap of ·003–·005 in. in position.

Fitting Gudgeon Pins

The gudgeon pins should be a push-fit in the pistons and a floating fit in the bronze-bushed small ends of the connecting rods. Spring circlips are used to keep the pins in position. Pistons should always be fitted with the split side on the camshaft side on the engine.

Fitting Valve Guides

Valve guides are pressed in position, but whereas the early type guides are collared the more recent ones are plain, which makes it necessary to ensure that replacements are not driven in too far. The guide should protrude approximately $\frac{3}{4}$-in. above the machined face of the valve spring recess. New guides can be either driven or drawn into position, but the latter method is preferable as it obviates the possibility of damaging the guide while fitting it. In lieu of a drawer, a long bolt, with nut and washer, and drilled plate to straddle the combustion chambers, will serve the purpose quite well.

Removing Cylinder Heads

Due to the fact that the size of the radiator tank has been increased, it is not possible to draw the cylinder heads of the current models straight off the studs as can be done with earlier models. If this is attempted it will be found that the front end of the head fouls the water pipe leading out of the radiator tank. It is therefore necessary to remove the two or three valve-cover studs, as these are longer than any of the other head studs. To accomplish this, first take off the rocker-shaft assembly complete, then, with the usual double-nut arrangement, unscrew the studs referred to, and in addition take off the thermostat packing piece,

after which the head may be removed in the usual way. As a matter of fact, head removal is simplified in all cases by the adoption of this method, but it is essential only in the case of the recent models.

When Fitting Thin Cylinder-head Gasket to Raise Compression

The fitting of a thin cylinder-head gasket, such as might be done with the object of raising the compression, may in some cases necessitate shortening the push-rods in order to allow the giving of valve-rocker clearance. The push-rod cups are pressed into the rods, and all that needs to be done is to saw-cut the tube immediately below the base of the cup, after which the cup may be driven farther into the tube a distance equalling the width of the cut. This will suffice to give the required clearance.

Valve and Ignition Timings

Valve and ignition timings are as follows: The inlet valve commences to open when the crankpin is 10° (six-cylinder) or 12° (four-cylinder) before top dead centre, the piston being within 1/16 in. (six-cylinder) or 3/64 in. (four-cylinder) of the top of its stroke, and closes when the crankpin is 50° (six-cylinder) or 52° (four-cylinder) past bottom dead centre.

The exhaust valve commences to open when the crankpin is 50° (six-cylinder) or 52° (four-cylinder) before bottom dead centre, the piston being $3\frac{3}{8}$ in. from the top of its stroke, and closes when the crankpin is 10° (six-cylinder) or 12° (four-cylinder) past top dead centre, the piston then being 1/32 in. from the top of its stroke.

The distributor points should commence to separate when the piston is at top dead centre position, with the manual ignition-control lever fully retarded.

It is easier to set the valve timing from the inlet closing point and check the exhaust opening, as the other points are so close to dead centre position that accurate measurement is difficult. The tappet clearance—·004 in.—should be verified before the timing is checked.

Remedying End Play in Water-pump Spindle

The water pump is of the usual vane type. The development of end play in the spindle is an indication of wear of the rotor boss and the spindle inner bush. This should be checked by the interposing of a hardened steel washer between the two faces, because if it is allowed to develop, the rotor vanes will eventually foul the inside of the pump case and will wear both the case and themselves.

Fitting Replacement Gland Packing in Water Pump

The fitting of a replacement gland packing does not necessarily involve the removal of the pump, and if the five bolts (or stud nuts, as

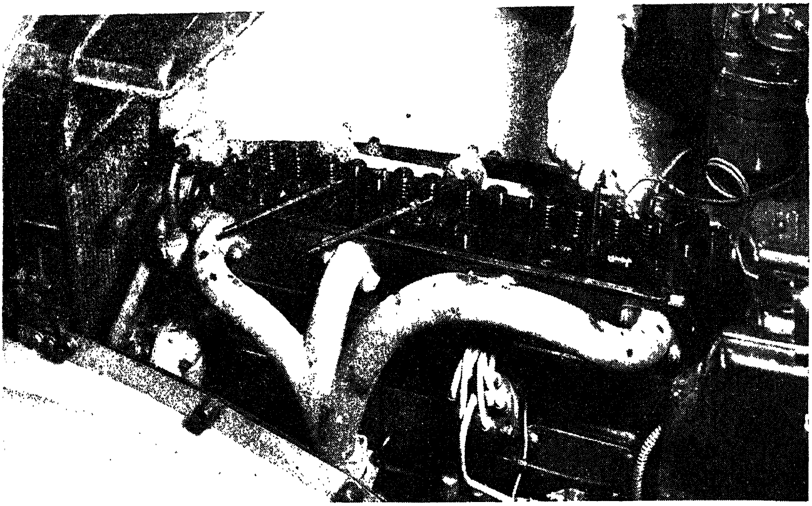


Fig. 14.—Removing valve cover studs to facilitate removal of cylinder head

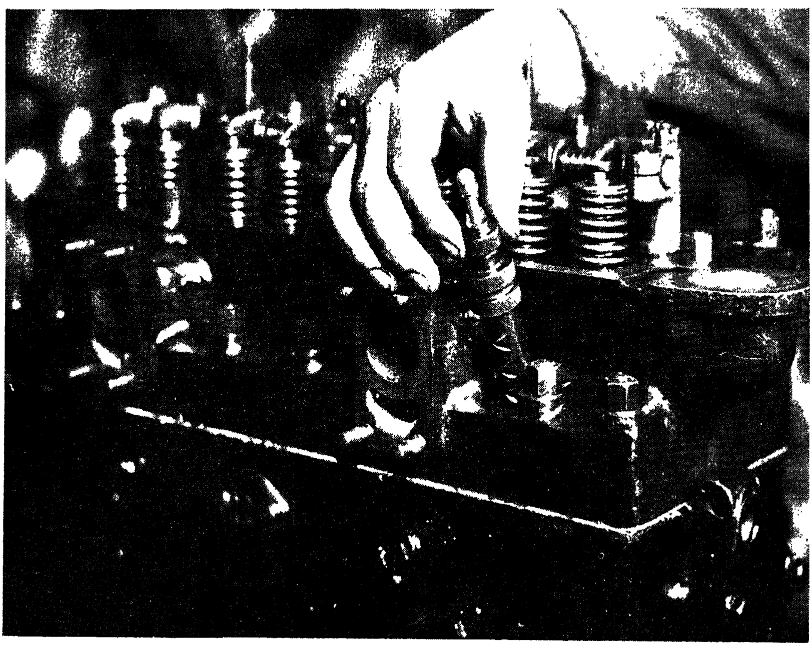


Fig. 15.—Timing tool for finding position of No. 1 piston

the case may be) holding together the two halves of the pump case are removed, the portion holding the gland can be taken away, after removing the split-pinned nut and washer, and tapping the pulley off the spindle. The gland nut can then be unscrewed and the gland and packing withdrawn. It should be noted that the gland is machined at one end, to fit the packing, and care should be taken to ensure that this is correctly refitted.



16.—ADJUSTING WATER PUMP GLAND
Showing locking tab removed.

EARLIER MODELS

Gloria Engine

There is little about the Gloria-type engine (the predecessor of the Dolomite and Vitesse range) to warrant detailed explanation. This engine was manufactured in four- and six-cylinder models, both designed on similar lines, with side exhaust and push-rod operated overhead inlet valves.

There are four types of engine : the Gloria 9·57-h.p. model, equipped with a single downdraft carburettor, either Solex or Zenith (or in the case of the "special" models with twin Zenith carburettors) ; the 10·8-h.p. types, fitted with a single S.U. carburettor (Gloria Vitesse model with two S.U. carburettors and the Monte Carlo model with two Zenith carburettors) ; and the six-cylinder 12·95-h.p. and 15·72-h.p. models, the former having two Zenith carburettors and the latter two Solex or S.U. carburettors.

A stroke of 90 mm. is common to all these engines, with the exception of the 15·72-h.p. models, which have a stroke of 100 mm. Bore diameters are 62 mm. (9·57-h.p. models), 66 mm. (10·8-h.p. models), 59 mm. (12·95-h.p. models, and 65 mm. (15·72-h.p. models). Respective capacities are 1,087, 1,232, 1,476, and 1,991 c.c.

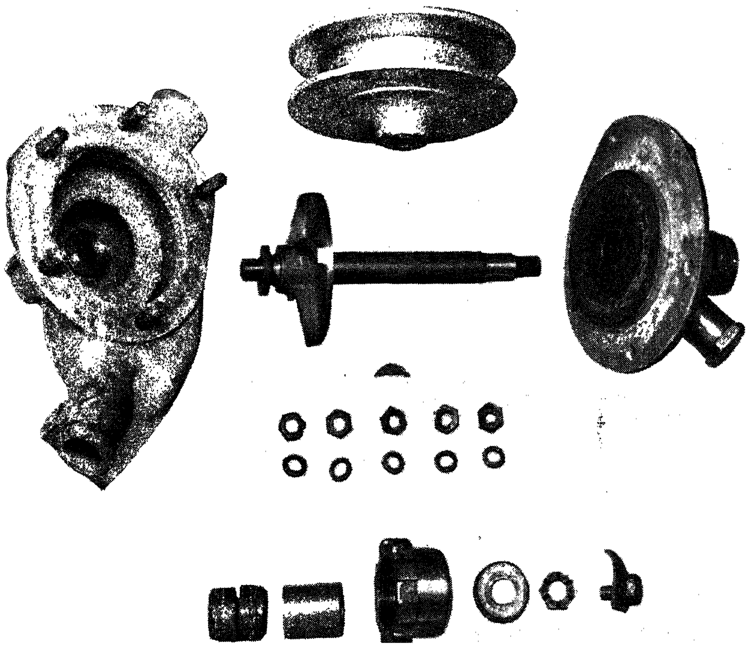


Fig. 17.—WATER PUMP ASSEMBLY

Tappet Clearances

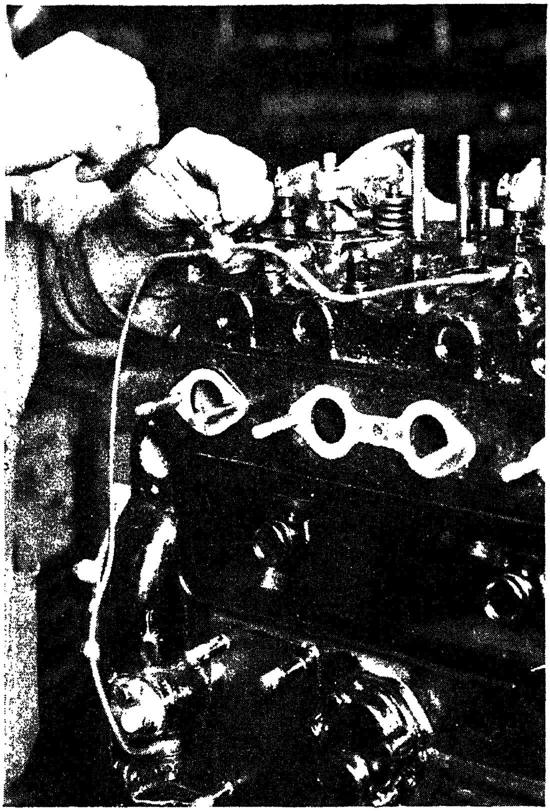
The tappet-guide blocks, each carrying four tappets, are detachable. The inlet valve tappets should be given a clearance of ·006 in., and the exhaust tappets ·004 in.

Curing Excessive Flow of Oil from Rockers

An excessive flow of oil from the inlet-valve rockers can appreciably affect the total consumption figure, as well as cause trouble with oiling of plugs, especially if the inlet-valve guides are worn. This difficulty may be overcome either by renewing the worn rocker bushes or by fitting replacement wicks in the drilled rockers. The former method needs no explanation, the only point to watch being that the new bushes should be fitted with the radiused end against the rocker-bracket shoulder in order to bring the oil grooves of bush and spindle into line. New bushes should be a push-fit both in the rockers and on the spindles.

The rocker channels are sealed at each end by a blob of solder, and after this has been removed and the channel cleaned, a short piece of wick, about 1 in. will do, should be inserted and the channel sealed again.

Another, and more economical, method of reducing the oil flow is to incorporate in the rocker feed pipe a restrictor valve, which can be obtained at small cost from the manufacturers. The fitting of this valve necessitates the cutting of the feed pipe in such a place that when the valve is fitted to the two cut ends, it will be accessible for subsequent adjustment. This valve is soldered in place, and use made of the adjusting screw till the flow from any individual rocker does not exceed thirty drops per minute when the engine is warm and running at idling speed.



18.—ADJUSTING RESTRICTOR VALVE ON GLORIA TYPE ENGINE

Refitting Sump of Four-cylinder 10·8-h.p. Engine

If the sump of the four-cylinder 10·8-h.p. engine is removed for any purpose, it is important that it and the filter are refitted separately. If an attempt is made to refit both parts *en bloc*, the end of the oil-pump suction pipe will almost certainly foul the top of the filter, in which case the latter will be crushed, and may obstruct the mouth of the pipe, resulting in lack of oil pressure, especially when the oil is cold. In fact, the filter should always be removed and examined before any other steps are taken, if oil-pressure trouble is experienced with this engine. When the sump is in position, it is a simple matter to push the filter into place. It is advisable to wire the filter attachment screws.

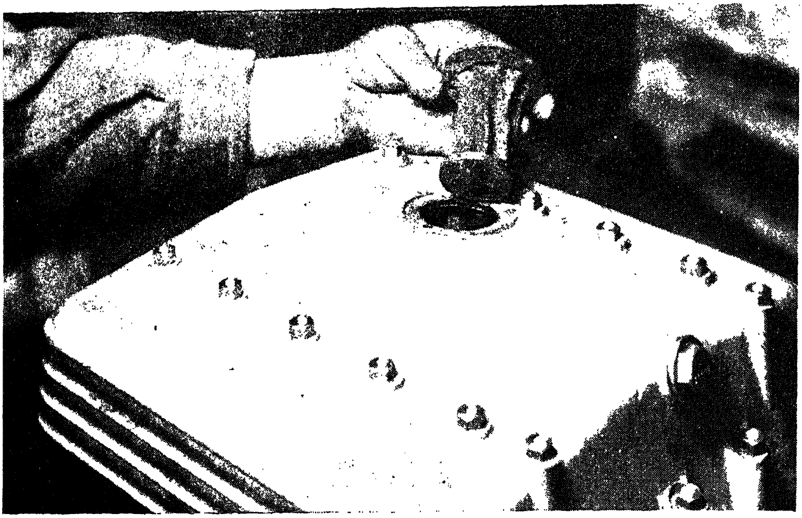


Fig. 19.—METHOD OF FITTING OIL FILTER WITH SUMP IN POSITION ON 10·8-H.P. ENGINE

Drop in Oil Pressure

A sudden drop in oil pressure may be caused by the presence of a piece of dirt between the relief-valve ball and seat, as, although a filter is fitted, a by-pass, allowing unfiltered oil to enter the crankcase galleries, comes into operation, on the 9·57-h.p. engine, if the filter is allowed to become choked. This relief valve will be found at the nearside front end of the crankcase of all the four-cylinder engines, and immediately below the water pump of the six-cylinder model. It is necessary only to take out the two bolts which hold the valve body to the crankcase, and the whole will come away. Either a ball or a plunger will be fitted, and if the former it should be renewed if it is pitted or indented. A washer may be fitted to increase the tension of the spring, if this appears to be insufficient. A pressure of 30–40 lb. per square inch at speeds of 30 m.p.h. or over is normal.

Indication of Main-bearing Wear

An oil leak from either end of the crankshaft (if the rear end, the oil will escape from the drain hole in the clutch housing) is an indication of bearing wear, and the appropriate steps, i.e. regrinding of the crankshaft and remetalling of the bearings, must be taken to cure this.

It is advisable to make sure, before undertaking any extensive engine repairs, that oil dripping from the escape hole in the clutch housing actually is engine oil. It may be an escape of gear oil resulting from over-filling, or failure of the gearbox front oil-retaining device.

Removing Pistons

Pistons of Triumph manufacture are fitted to the 9·57-h.p. and 12·95-h.p. engines, and B.H.B. pistons to the 10·8-h.p. and 15·72-h.p. models. The former are removable from the underside of the engine, but the other types must be withdrawn in accordance with the method described earlier in these notes, i.e. from the top, the only exception being that the 10·8-h.p. model connecting rods will pass through the cylinder bores. A clamp-bolt method of gudgeon-pin and connecting-rod attachment is used, except in the case of the 15·72-h.p. engine. The latter have floating gudgeon pins, held by circlips.

Adjustment of Carburettors

The adjustment of the two S.U. carburettors fitted to the Gloria Vitesse four-cylinder engine requires a brief explanation. These carburettors are differentially operated, so that the downdraft model fitted over the cylinder head comes into action later than the horizontal one fitted at the side. The downdraft carburettor should be put out of action by disconnecting it from the spring-loaded coupling rod, and the horizontal carburettor adjusted in accordance with the instructions given elsewhere in this publication. This adjustment having been satisfactorily accomplished, the downdraft carburettor is recoupled and use made of the adjustment provided on the coupling rod, so that a delay action of about $\frac{5}{8}$ in. is given. Actually, the downdraft carburettor should commence to operate at an engine speed of about 2,800 r.p.m., though this figure may be varied to suit individual engines and owners' requirements. The mixture control of the downdraft carburettor should be set about two or two and a half turns open.

With the exception of the last sentence and the fact that both carburettors are downdraft types, these remarks on carburettor adjustment apply equally to the twin Zenith carburettor equipped 9·57-h.p. Monte Carlo and Gloria "special" types.

Reassembling Filter of 9·57-h.p. Engine

If the filter of the 9·57-h.p. engine is dismantled for the fitting of a new element or for cleaning, it is advisable to note, when reassembling it, that the double-shouldered plate fits at the top of the body, which is recessed for the purpose, and the dished-bottom locator is pushed up against the element, by the short spring which fits the recess in the filter-body cap. The by-pass valve mentioned earlier comprises a ball, a spring some 2 in. in length, and a spring guide which screws into the large nut fitted in the top of the filter body. To assemble this, the ball is dropped on to its seat, then the spring is fitted (ensuring that its lower end locates properly on the ball), and lastly the nut and spring guide complete.

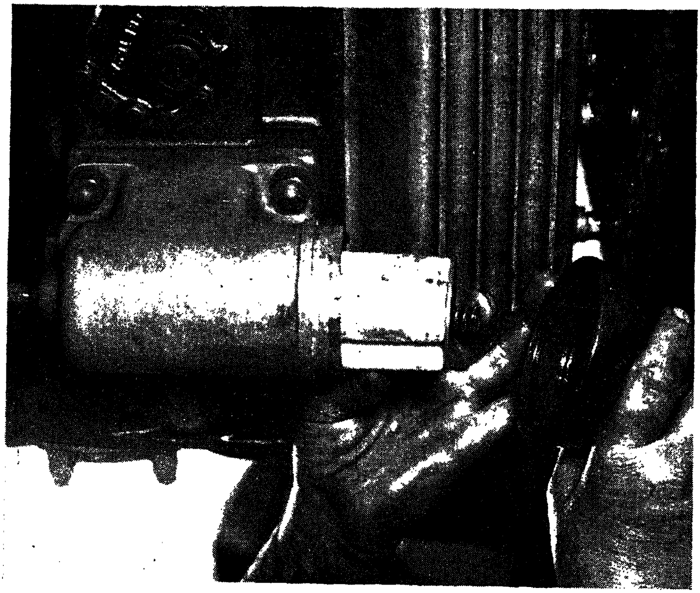


Fig. 20.—ASSEMBLING OIL FILTER ON 9·5-H.P. ENGINE

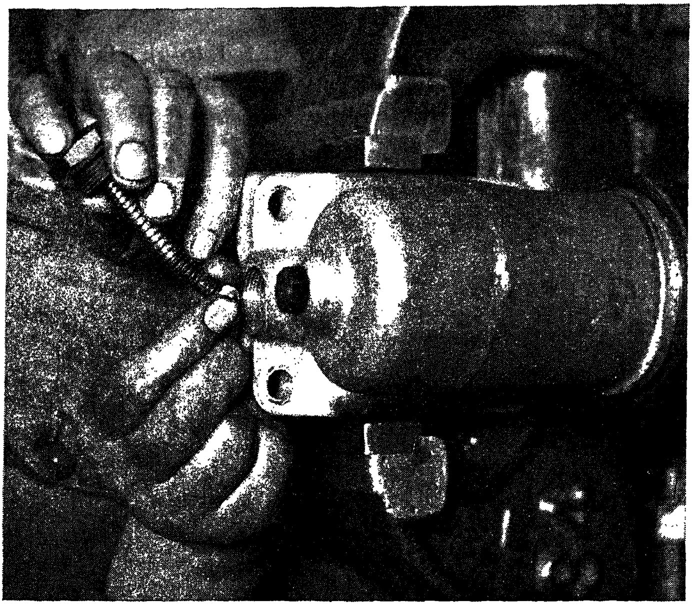


Fig. 21.—FITTING RELIEF VALVE ON 9·5-H.P. ENGINE OIL FILTER

Care Needed when Refitting Oil-pump Suction Pipe

If the oil-pump suction pipe is detached from the crankcase (as would be done in the case of a complete overhaul, for example), care should be taken when refitting not to omit the ball which rests on the top of the pipe flange. The function of this ball is to retain oil in the crankcase galleries when the engine, and with it the pump, is stopped. Omission of the ball will allow the galleries and pump to drain, and considerable damage might be caused to the bearings, etc., during the brief interval which would elapse before the pump could refill the galleries, following the restarting of the engine.

Oil Pump on the 10·8-h.p. Engine

The paper washer or washers which will be found between the body of the 10·8-h.p. oil pump and the crankcase and between the two halves of the pump body should not be omitted when reassembling. The latter is specially important, as in addition to keeping the body oil-tight it provides the necessary end clearance on the gear. Nor must the hardened steel washer which fits behind the pump skew-gear be left out.

Removal and Overhaul of Water Pump on Six-cylinder Engine

The water pump of the six-cylinder model is chain-driven, and as its removal and overhaul are a little complicated, a few notes will be useful. First it is necessary to take off the distributor, and to obviate the necessity of retiming the distributor should be set with the rotor arm pointing to No. 1 cylinder and the contact points just separating. First gear should then be engaged and the hand-brake pulled on. Now the distributor may be taken off and the water-pump connections unfastened. The pump is attached to the timing case by two bolts and one stud. Take off the two bolt nuts and the one stud nut and remove the stud. Slack off the adjusting pin, undo the dynamo straps, and lodge the dynamo on the cylinder head. Swivel the dynamo cradle upwards out of the way. Take off the inspection cover in front of the water pump and lift the chain off the wheel, having first swivelled the pump towards the engine to slacken the chain. The pump may now be manipulated away and the chain strung or wired to prevent it falling into the timing case.

A drain hole is provided in the underside of the pump body, and a leakage of water through this hole is an indication of gland wear. Leakage of oil denotes spindle-bush wear. It is a mistake to plug this hole in the event of a water leakage, as the water will find its way into the timing case if this is done.

In addition to the fitting of a replacement carbon gland, two points should be observed and rectified when overhauling one of these pumps. First, the presence of end float in excess of about ·002 in. in the spindle, even when the male driving dog has been screwed fully home against

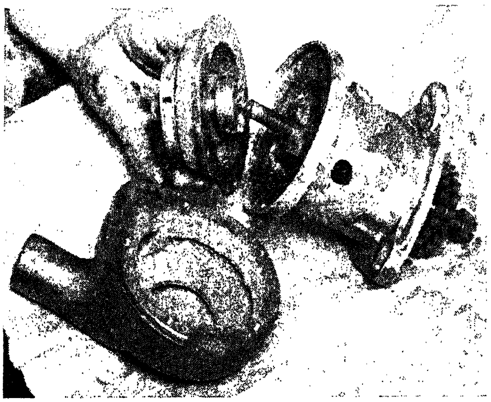


Fig. 22.—WATER PUMP OF 15·72-H.P. ENGINE BEING DISMANTLED

the spindle bush; and second, spindle-bush wear, which will allow the spindle to run out of true. Both these defects will cause rapid gland wear with consequent water leakage. Spindle end float may be cured by fitting shims behind the rear spindle bush, but new bushes will be necessary to overcome lateral movement of the spindle. Also, it is important that the truth of the spindle itself should be confirmed. The carbon gland is pressed in, and this operation should be carried out with care, as the gland is brittle and therefore liable to break. A slight water leak may be noticeable after the pump has been refitted, but everything else having been done correctly, this will cease as soon as the female driving dog beds down on the gland.

Recommended Valve and Ignition Timings

The following valve and ignition timings are recommended:

The inlet valve commences to open when the crankpin is 10° before top dead centre, the piston being within 3/64 in. of the top of its stroke, and closes when the crankpin is 50° past bottom dead centre, the piston being $3\frac{1}{32}$ in. from the top of its stroke.

The exhaust valve commences to open when the crankpin is 50° before bottom dead centre, the piston being $3\frac{1}{32}$ in. from the top of its stroke, and closes when the crankpin is 10° past top dead centre, the piston being 3/64 in. from the top of its stroke.

Note.—Before checking timing it is important to see that the tappet clearances are correct.

All "Gloria" Models.—Manual control lever on the column should be fully advanced and the contact-breaker points should be just separating when the piston is on the top of the compression stroke (both valves closed).

The firing order of all the four-cylinder engines is 1, 3, 4, 2, and of the six-cylinder models 1, 5, 3, 6, 2, 4.

Carburettors and recommended settings from 1934 onwards are as follows:

CARBURETTORS AND THEIR RECOMMENDED SETTINGS

Year	*Model*	*Make of Carburettor*	*Type of Carburettor*	*No. of Carburettors*	*Needle size*	*Choke*	*Main Jet*	*Compensator Jet*	*Slow-running or Pilot Jet*	*Petrol Consumption m.p.g.*	*Remarks*
1934	Gloria 9·57 Standard	Solex	Downdraft	1	—	25	110/57	—	50	30	—
	Gloria 9·57 Standard	Zenith	Downdraft	1	—	25	105	70	—	30	—
	Gloria Special and Monte Carlo 9·57	Zenith	Downdraft	2	—	No. 1 21 No. 2 24	50 65	95 115	—	28	Action 2nd Carburettor delayed
	Gloria 12·95 Standard	Zenith	Downdraft	2	—	21	85	90	60	24	—
	Gloria 12·95 Special	Zenith	Downdraft	2	—	21	80	90	60	22/23	—
	Gloria 12·95 Standard and Special	Zenith	Downdraft	2	—	No. 1 17 No. 2 24	65 75	No. 1 65, No. 2 80/85	—	22/23	With delayed action, 2nd carburetter
1935 and 1936	Gloria 9·57 Models	As	1934								
	Gloria 10·8 Standard	S.U.	Horizontal	1	No. 1 or M.A. (weak)	—	—	—	—	28	—
	Gloria 10·8 Vitesse	S.U.	1 Horizontal	2	CX	—	—	—	—	26	Downdraft action delayed
			1 Downdraft	—	4	—	—	—	—	—	
	Gloria 15·72 Standard	Solex	Horizontal	1	—	25	130/57	—	60	22/23	
	Gloria 15·72 Vitesse	Solex	Horizontal	2	—	22	110/57	—	55	20/22	—
	Gloria 15·72 Vitesse	S.U.	45° (1¼ in.)	2	4	—	—	—	—	20/22	—
1937	Gloria and Southern Cross (10·8)	As	1935/6								
	14/60 Vitesse and Dolomite	S.U.	Horizontal	2	CD or 3 (weak)	—	—	—	—	24/26	—
	2 litre Vitesse and Dolomite	S.U.	Horizontal	2	CB or S4 (weak)	—	—	—	—	20/22	—
	1½ litre (1496 c.c.)	Solex	Horizontal	1	—	26	120	—	55	28	—
1938	1½ litre and 2 litre models	As	1937								
	1½ litre (1496 c.c.)	Solex	Horizontal	2	—	22	105	—	55	26/27	—
	14/60 Dolomite and Vitesse	Solex	Horizontal	2	—	24	115	—	55	24/26	—
	Gloria "Fourteen" (14/60)	Solex	Horizontal	1	—	27	130	—	55	26	—

Carburrettors for 1939 models, *see next page.*

CARBURETTORS FOR 1939 MODELS AND RECOMMENDED SETTINGS

Model	*Make of Carburettor*	*Type of Carburettor*	*No. of Carburettors*	*Needle size*	*Petrol Consumption m.p.g.*
2 litre Dolomite	As 1938				
2 litre Dolomite (Royal and Roadster)	S.U.	Horizontal	3	No. 1	20/21
14/60 and 1½ litre (1767 c.c.)	S.U. 1¼ in. throat	Horizontal	2	A.U. or M.A. (weak)	24/26

REPAIR OF COMMER VEHICLES

THE ENGINE, CLUTCH, AND GEARBOX

By B. M. SMITH

THE following information has been compiled in order that all repairers of Commer vehicles may be in a position to carry out repairs or overhauls in the most expeditious manner, without unnecessary loss of time due to an imperfect knowledge of the correct sequence of operations.

For general maintenance work it is proposed to separate the entire range into three general types, i.e. 8-cwt.; 15-cwt. and 20/25-cwt.; and N.2/3 and 5 tons, dealing with each group separately.

8-CWT. VAN

Briefly this, the smallest of the range, consists of a four-cylinder engine, 63 mm. × 95 mm., driving, through a single-plate clutch, a synchromesh gearbox with four forward gears and reverse.

Engine Suspension

The engine unit is suspended on non-adjustable rubbers, and when removed at any time care must be taken to make sure that the front support rubbers are fitted in the correct position.

It will be noted that these rubbers are cast on to a steel sleeve, and on the rubber the word "TOP" is also cast.

However, should this be indiscernible it should be noted that there are two air holes moulded in the top half of the rubber. On either side of the rubber, die-cast shallow cone washers are fitted.

The rear suspension consists of a special bracket formed on the gearbox, and lugs on the mounting bracket, between which is sandwiched a rectangular block of rubber.

Also on this rear gearbox bracket is formed a mounting for a U-shaped rubber block. A strap passes over the end of this block, the ends of which are secured to the chassis bracket by means of two bolts. On these two bolts, distance pieces 15 mm. long are fitted.

We would stress that all dimensions are fixed, and no adjustment to the rubbers can be obtained, nor is this necessary.

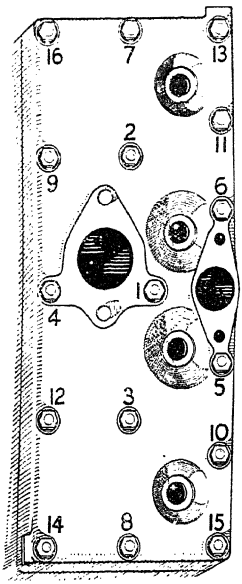


Fig. 1.—CYLINDER HEAD 8-CWT. VAN
Showing order of tightening nuts.

ENGINE UNIT (8-CWT. VAN)

Removing Dynamo and Fan

The 6-volt dynamo, which is carried on the cylinder head, can easily be removed—after disconnecting the wiring. The fan belt, which is of the endless rubber type, should first be levered off the pulley, when it is necessary only to remove the setscrews holding the dynamo to the bracket.

The fan is held on to the end of the armature shaft by setscrews or studs, and should be removed during the winter months.

As the fan is balanced, it must be replaced in correct relation to the dynamo drive pulley, and to facilitate this the fan and pulley carry centre-punch marks.

Decarbonising

After draining the water and disconnecting the top hose, the dynamo should first be removed in the manner detailed above.

The two setscrews holding the distributor bracket are then removed, allowing this component to be withdrawn, and after removing the remaining cylinder-head nuts the head can be lifted off.

The dog drive for the distributor is offset, which obviates any possibility of incorrect reassembly.

The cylinder head is provided with lugs to allow the insertion of a thin lever should the head be tight. When replacing the cylinder head the gasket must be refitted the correct way up, and the gasket is stamped accordingly.

Further, the cylinder-head nuts must be tightened in the order shown on Fig. 1.

The tappets are carried in detachable blocks held in the valve chest by setscrews and dowels, and it is advisable to remove these in order to give free access to the cotters.

Great care must be taken that cotters are not dropped, and it is recommended that a shield or clean wiper is laid on the camshaft to catch any which may inadvertently be allowed to slip.

It is also advantageous to remove the manifold and carburettor complete, to give additional space in which to work. It will be noted that manifold joints must be replaced the correct way up, otherwise the ports will be partly blanked off, resulting in an unaccountable loss of power.

No external oil filters are incorporated, and the sump should be

removed at stated intervals for cleaning. This will also expose the submerged oil pump, which is covered with an easily removable gauze.

To Remove Oil Pump

To withdraw the pump, the engine must first be turned until Nos. 1 and 4 pistons are at T.D.C., No. 4 being on the firing stroke.

The nuts holding the pump to cylinder block are then removed, when the pump can be withdrawn downwards.

Replacing Pump

It is particularly important that the following procedure is carried out exactly as detailed, as the pump dogs are offset and otherwise difficulty would be experienced in replacing.

Turn the oil-pump shaft so that the slot of the uni-directional coupling lies parallel with the line taken across the securing-bolt holes—the smallest segment being to the camshaft. Again make sure that engine is at No. 4 firing T.D.C.

Place oil-pump shaft in position in hole in block, and line up fixing holes in oil pump with fixing studs in cylinder block. *Do not omit the oil baffle between pump and block.* Press oil pump straight home, when it will be found that the drive gear unites with the correct teeth, causing the pump shaft to rotate into position.

Pistons can easily be withdrawn from below after the sump is removed, provided they are drawn out on the near side of the engine.

Tab washers are used to lock the big-end nuts, and no attempt should be made to use these again ; new tabs should always be fitted.

Replacing Pistons and Rods

When replacing pistons it is always advisable to use a clip of some sort to retain the rings in their relative positions as regards gaps, and to obviate any risk of breakage.

Naturally the pistons and rods must be replaced the same way round—particularly those rods incorporating an oil jet.

This modification, which was introduced at chassis 7000879 and deleted at chassis 7001468, allows oil fed under pressure to the big-end bearings to pass out through the side of these bearings on to the camshaft and tappet assemblies.

The connecting rods having this jet are numbered, and should be replaced so that the number is on the camshaft side.

On models not incorporating this jet the numbered side of the rod should be fitted *away* from the camshaft.

Connecting-rod Bearings

Connecting rods are fitted with detachable white-metal steel-backed shells, and owing to the accurate finish of all parts no hand fitting is required.

No attempt must at any time be made to let up big-end caps, as not only will this distort the bearing but it will render the rods non-standard, and therefore not eligible for exchange under the makers' scheme.

Ignition Timing

Ignition timing is correctly set when with the points having a gap of ·010 in., they are just breaking at T.D.C.

On the earlier models having no suction control the points should break at 7° before T.D.C.

To check the timing, the engine should be turned until the saw-cut or V in the fan pulley is vertical. Should any alteration be required, slack the clamping screw of the arm attached to the distributor stem. This will allow the distributor to be turned so that the points open at the required position.

Valve Timing

Should this at any time be disturbed it will be found that the cam-shaft and crankshaft pinions are marked on the teeth with a centre punch.

It is only necessary to turn the pinions until the punch-marks coincide on an imaginary line drawn between the pinion centres.

When checking timing it is necessary first to increase the tappet clearances to ·018 in., taking care to reset on completion to ·010-in. inlet and ·015-in. exhaust.

When replacing the timing-case cover the following procedure should be adopted :

Place the timing cover in position, taking care not to damage the paper joint, and locate with one or two of the fixing bolts, but do not tighten up.

Next place the fan pulley in position and secure with the starter dog. Replace the remaining setscrew or bolts, tightening until the cover is just nipped but not secured.

The engine should then be run for a short period, when the cover will automatically centre itself about the fan pulley, and the nuts can be fully tightened.

Unless this method is adopted there is a risk of oil leaks due to the oil retainer not functioning correctly.

Carburettor

Earlier models, commencing with chassis number 7000637, were fitted with a Solex 30 A.I.P. down-draught type. From chassis 7100500 a Solex 30 F.A.I. pattern is used. Full details of these models are dealt with separately in Vol. I.

Removal of Engine

To remove the engine from the chassis for general attention the procedure detailed will avoid unnecessary dismantling.

Remove front floorboards and disconnect the propeller shaft behind the gearbox. Support the engine at the rear with a jack, and remove the gearbox as detailed under that section.

The radiator can be removed complete with tie-bars, and all accessories, such as petrol pipes, exhaust pipe, etc., must be disconnected.

A steel strap should be fitted to the cylinder-head nuts so that the weight of the engine can be carried in order to allow the bolts passing through the front rubber suspension to be removed.

The unit should then be lifted upwards to clear engine bearer brackets and outwards to clear dash pan.

Attention is again drawn to the necessity of replacing the support rubbers correctly when reassembling the engine in the chassis.

Dismantling

Should it be found necessary to remove the crankshaft, no special difficulty will be encountered, with the possible exception of the rear main-bearing cap. Owing to the fact that cork packing is used to fill the grooves in the side of the cap in order to make an oil-tight seal, it will probably be necessary to use a bridge-type extractor, and to facilitate this the cap is suitably drilled and tapped $\frac{5}{16}$ in. B.S.F.

When replacing this cap it is advisable to start it in the cylinder block aperture at an angle, only swinging into a normal position when the studs are reached.

If, in addition, the cork seals are oiled before fitting, it should easily be possible to refit without damage.

The main bearings are steel-backed white-metalled shells, and owing to the accurate machining no hand fitting is required, nor must the caps at any time be filed in an endeavour to take up wear.

At the rear, main bearing detachable bronze flanges are fitted to take end thrust, the flange at the rear being thicker than the flange at the front face. These flanges are in halves and the front one is dowelled to the bearing cap only, but the rear is dowelled to the block.

End float in the crankshaft is controlled by varying the thickness of these flanges, the correct clearance being ·003 in. to ·006 in.

Undersize bearings for both crank and connecting rods can be obtained in ·010 in., ·020 in., ·030 in., and ·040 in.

CLUTCH AND GEARBOX (8-CWT. VAN)

This is of the Borg & Beck pattern, for which full instructions are given separately in Vol. I, and in its present application offers no difficulties.

Should the flywheel at any time be removed, care must be taken that it is replaced in its correct relation, as otherwise the valve-timing marking will be misleading.

It is most important that the flywheel should fit squarely on to the

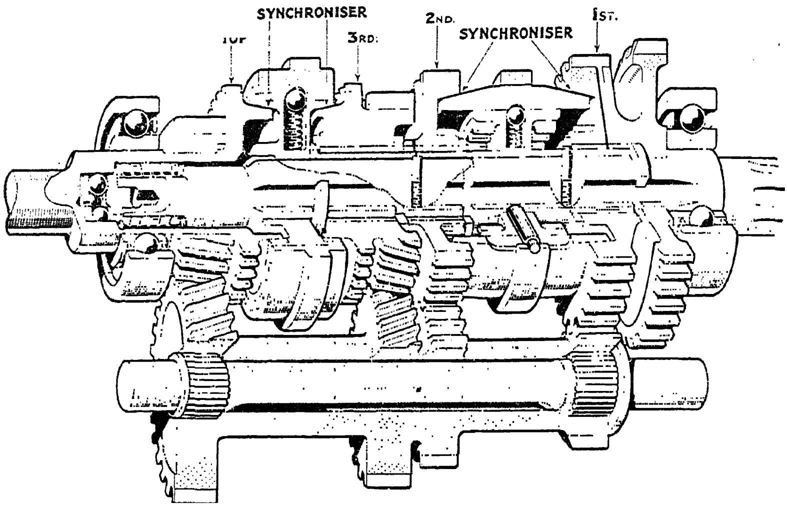


Fig. 2.—GENERAL ARRANGEMENT OF GEARS. (8-CWT. VAN)

crankshaft and that the four setscrews are fully tightened and secured with new locking plates.

If the starter ring is found to be worn excessively, an exchange system is operated by the factory whereby a reconditioned flywheel and starter-ring assembly are supplied at a nominal figure.

To remove the gearbox, disconnect propeller shaft and all external attachments such as speedometer cable, handbrake lever, etc.

After putting a jack under the rear of the engine, remove the four bolts securing the rear support bracket to cross-member. Then remove the two upper securing bolts and starter-pinion cover, afterwards replacing the nearside starter securing bolt. Finally, undo the bolts securing the bell housing to engine and remove the box by drawing backwards and upwards.

Dismantling Gearbox

The following details apply to the fully synchromesh type of box used for some years past, but that now in use, commencing with chassis number 7100500, and of which details are given later, is only synchromesh on top, third, and second.

To dismantle the box it is necessary first to remove the bell housing and then the top cover carrying the gear lever.

The rear coupling should next be removed, after which the rear suspension can be dismantled, thus allowing removal of the gearbox rear cover. It will be noted that one setscrew has a rubber cap.

The oil retainer, speedometer pinion, and steel distance-piece are then taken away.

Remove reverse-shaft locking plate, invert gearbox, and remove base cover and front cover.

Important.—We strongly advise the use of a dummy layshaft inner shaft—6½ in. long by ¾ in.

Further, the following precautions must be taken.

Special Instructions for removing Layshaft

The layshaft inner shaft is undercut on its lower face to provide an oil reservoir. If the gearbox be inverted when the inner shaft is withdrawn there is a possibility of the needle rollers on which the layshaft is carried dropping into this undercut, and thus rendering the removal of the shaft impossible.

The layshaft should therefore be driven out a very short distance to the rear and as soon as possible turned through half a turn.

Using the driving shaft referred to above, the inner shaft should be driven out.

The small steel washer can then be pushed out from the rear end of the layshaft cluster, allowing this cluster to be pushed forward to clear the bronze thrust pad, which is pegged to the gearbox case and fitted in a recess in the layshaft cluster.

The bronze thrusts pegged to the front and rear faces of the box can then be removed, followed by the reverse wheel shaft and wheel.

The gearbox should now be turned to its original position.

Removing Selector Shaft

Remove the grub screw locating the selector shaft and turn the front cover so that the slot is opposite the selector shaft. Obtain two pieces of ½-in. diameter round steel approximately 1 in. in length. Drive the selector shaft to the rear very carefully, taking care not to move the third and top fork.

As soon as the grub-screw hole in the selector shaft appears, turn the selector shaft by means of a small lever inserted in this hole, so that the selector balls do not drop into the grooves.

Withdraw the shaft, following up with the dummy shaft, so that the balls are retained in the forks.

Withdraw the stem wheel complete with bearing and front cover, so that the four loose balls and thrust bearing in the spigot are not displaced.

Removing Mainshaft Assembly

Draw third and top synchromesh assembly forward, lifting off the selector fork when convenient.

Drive mainshaft assembly towards front of box, using a piece of tube over the rear end of the shaft, and then remove first and second fork.

Again invert the box and lift the rear end of the shaft, so that the assembly can be withdrawn.

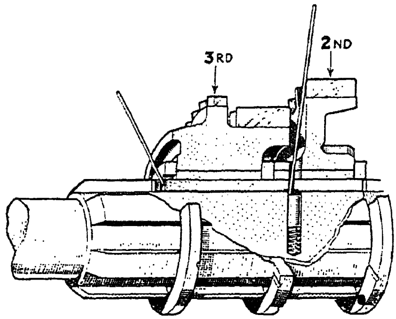


Fig. 3.—SHOWING DETAILS FOR REMOVAL OF KEY SECURING 3RD AND 2ND GEAR WASHERS

Note that the layshaft is carried on twenty-seven needle roller bearings at each end, and that there is a small steel ring at the front.

The mainshaft assembly can more easily be dismantled if the rear end be clamped in a vice with the key securing washers uppermost.

Turn second-speed wheel until the hole in the boss is in line with the key, and then insert a thin rod so as to depress the spring-loaded pin and allow the key to be withdrawn.

Turn steel washer one-sixth of a turn and pull over spline, thus enabling the third gear and bronze bush to be removed.

The thick steel washer and second-speed wheel are similarly removed.

Press down locking plunger and remove bronze bush, followed by steel washer and first and second cone assembly.

Similarly depress the second locking plunger and remove steel washer, first-speed wheel, and bush.

Note.—Take care that the plungers and springs do not fly out, and label steel washers, as these must not be interchanged.

Now remove the shaft from the vice and drive mainshaft forward through the reverse wheel. After removing both halves of the washer in front of the reverse wheel, this and the ball race can be moved forward.

Synchromesh Assemblies

To dismantle first and second gears, drive the three securing pins inward and remove the ring, then push inner member from cones.

For third and top give the cone member a sharp blow with a rubber or hide mallet, driving the member a short distance within the ring in order to release balls from the groove, then push cone member from dog.

It is strongly advised that the assemblies be kept in small separate boxes, to avoid possible loss of the spring-loaded balls.

To reassemble it is essential to use two special tools in order that the springs behind the balls are compressed to allow the inner member to be replaced. One spring and ball is inserted and compressed at a time, the inner member being rotated in the ring to hold the ball in position.

In the case of third and top, the member must be pushed towards the end of the tool incorporating the compressing teeth.

Further, the ring for the selector fork is not central but offset, and the ends of the dog farthest from the ring for the fork should face the same way as the boss on the inner member.

When assembled, the boss on the inner member and the longer portion of the dogs face the stem wheel.

The inner member of the first and second gears cannot be replaced incorrectly.

Fitting New Thrust Washers

If it is found necessary to fit new thrust washers for second and third gears it is essential that they be fitted correctly.

For this purpose new washers are slightly oversize, to allow equal amounts to be rubbed off each face until they are a tight fit in the grooves in the shaft.

Three of the four washers have oil grooves on one side alone, this grooved face being fitted against the respective bush. Further, each thin washer has one spline recessed.

In the case of the first-speed wheel the plunger fits in this recess, and in the case of the last washer fitted this recess should be over the key to permit access to the hole in the key for a second pointer, so as to allow the key being pulled out after the locking plunger has been depressed.

Adjusting Mainshaft End Float

End float on the mainshaft is adjusted by means of shims fitted below the hardened thrust button, which in turn is below the four thrust balls in the spigot bearing.

Should adjustment be necessary the mainshaft should be assembled in the box, bolting the front cover in position, and driving the mainshaft rear ball race fully home.

Then set a depth gauge to the depth of the recess in the rear cover, comparing the amount the ball race stands out from the rear of the box, allowing for the paper washer.

The depth of the recess should be ·004 in. to ·006 in. greater than the amount the ball race stands forward.

Adjustment is effected by removing the front cover and adding or taking away shims from under the thrust button until the required dimension is obtained.

This must be done before the layshaft is fitted.

Notes on Reassembling

The reverse shaft must be fitted after the mainshaft and before the layshaft.

When engaging layshaft great care must be taken to mesh the third-speed wheel in accordance with the marked teeth, so that they run with the same teeth as before.

Remember to turn the layshaft inner shaft to prevent the needle rollers falling into the recess.

The correct layshaft end float is ·004 in. to ·006 in.; if excessive, fit new bronze thrust washers.

When replacing the top cover make sure the third- and top-gear fork is in its neutral position, and that the pin on this fork engages with the hole on the sliding plate fixed to the lid.

The tension of the selector springs can be adjusted by screwing the spring caps in or out after removing the locking wires.

The reverse spring cannot be adjusted.

Present Type of Gearbox

Dealing with the present type of gearbox, it is proposed to enumerate only the items in which it varies from the earlier pattern.

As the box has no bottom cover plate and need not be inverted, it is recommended that the gearbox be held in a vice by the flats on the drain plug. When correctly inserted the dummy layshaft will hold the rollers and steel thrust washers—but allow the layshaft assembly to drop into the lower portion of the box.

Now remove selector shafts and selectors, as already detailed, followed by first-motion assembly and top and third synchromesh.

The mainshaft is then driven forward, and removed through front of box.

Next lift out first- and second-gear assembly, and then the layshaft, taking care to keep the latter horizontal to avoid movement of the dummy shaft. Finally, remove the layshaft cluster through the front of the box, allowing access to reverse shaft and gears.

Note

An oil-return scroll is cut on the rear coupling, and there must be between ·003 in. and ·005 in. clearance. Care should be taken to see that there is no paint at this point.

Further, excessive end float of the speedometer-drive wheel must be avoided, otherwise oil will be pumped up the speedometer cable. Minimum clearance, ·004 in.

The first motion shaft bearing is held by circlips, and the rear bearing is also located in the housing, so that end-float adjustment of the mainshaft assembly is unnecessary.

Mainshaft Assembly

To dismantle, remove the circlip securing thrust washer to shaft, enabling third and second gears to slide off.

When rebuilding, it is essential to see that there is ·006-in. end float on the gear assembly. This is adjusted by the thickness of the circlip or thrust washer below it.

Check between the thrust washer and circlip at two or three points, to avoid a possible incorrect reading, should the circlip be not perfectly flat. Always use a new circlip.

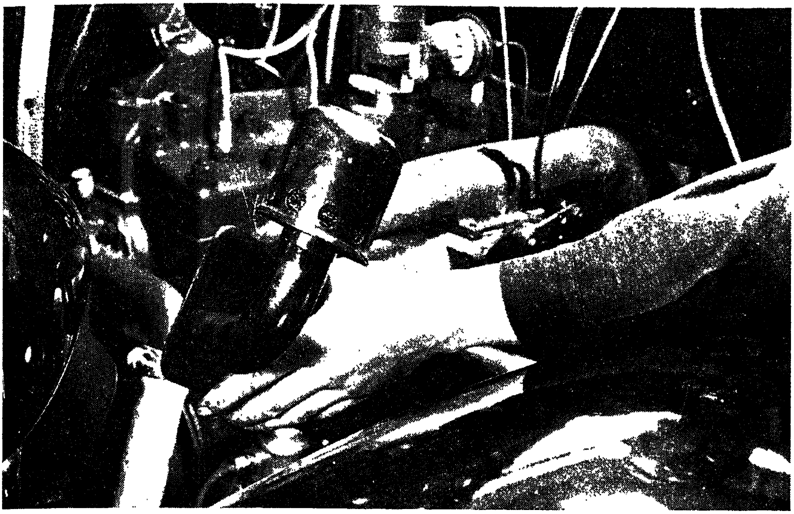


Fig. 4.—TAPPET ADJUSTMENT. (LATEST TYPE ENGINE, N1 AND 15-CWT. VAN)
Removal of tappet cover before commencement of tappet adjustment.

First and Second Gears

Very special care must be used when reassembling, as if incorrectly done, it may cause cone rubbing or failure of synchromesh in second gear, or even first gear to stick in.

When stripping, it is advisable to cover the assembly with a rag to prevent the balls from being lost, after which the outer member can be pushed from the inner.

It will be seen that in addition to the six spring-loaded balls, there is a plunger and ball in a seventh hole in the inner member.

This is used to lock the inner member to the mainshaft when first gear is engaged, and thus to stop the inner member being pushed on to the second-gear cone.

Should this plunger not operate when first gear is engaged, the second-gear cones will rub.

Equally so, the cones must engage when second gear is operated, and in this position the plunger must not lock the inner member to the mainshaft.

One of the internal teeth on the outer member is cut away from the groove in which the synchromesh balls operate, and this tooth is the one which must operate the plunger.

When rebuilding, therefore, it is of the greatest importance that this cut-away tooth fits exactly over the ball which caps the plunger.

Apart from this, the length of plunger is important, and before reassembling should be checked as follows :

Assemble inner and outer members on to mainshaft with only the one plunger and ball in place, and then push the outer member from the neutral position so that the plunger is depressed.

Push inner member towards front end of mainshaft, when there should be ·010 in. to ·020 in. end float between rear end of inner member and rear end of splines on mainshaft.

Insufficient clearance will cause sticking in first gear.

When finally assembled, the sliding gear should be over the cone in the hub if the outer member is the correct way round.

Layshaft Sub-assembly

When rebuilt, check end float between steel and bronze thrust washers.

This should be ·006 in. to ·008 in., and selective steel washers can be obtained.

It is essential that first gear is a good fit on the splines, as an excessive clearance will possibly lead to jumping out of gear.

The correct load on the synchromesh cones is 40–46 lb. for third and top, and 50–56 lb. for second gear.

Should it be desired to increase the tension of the synchromesh ball springs, shims can be obtained to fit in the bottom of the holes.

As a rough guide, a shim in three holes will increase the load by approximately 10 lb.

It is important that shims are placed in holes equally spaced—for instance, if three are fitted, they should be in every alternate hole.

15-CWT. (4-CYLINDER) AND N1 MODELS

These two models were introduced at the same time, and units used in their construction are basically the same. No attempt, therefore, is made to treat them separately, but where a vital difference occurs reference to it is made in the section devoted to the unit concerned.

Certain modifications have been made from time to time, the most important occurring simultaneously and being a complete re-design of engine unit, a change from negative to positive earth return, and the introduction of a V.B.F.D. type of Solex carburettor in place of the B.F.D.V. This latter is, in effect, a change from the " 12 × 300 " jet cap to " 20 " assembly. The remaining alterations to design which have taken place are, in the main, detail changes and very few affect the method of construction or repair.

It will be realised, however, that the service angle is influenced in one or two cases, especially by the change in engine design, and where necessary an indication as to the effect of any modification is given.

Information has been grouped, so far as possible, under the respective units in order to attain simplicity.

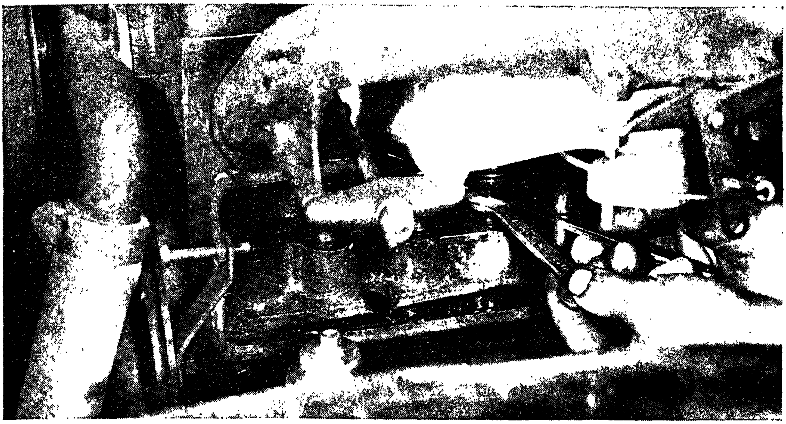


Fig. 5.—ADJUSTMENT OF TAPPETS. (LATEST TYPE ENGINE, N1 AND 15-CWT. VAN)
Note carburettor has been removed.

Engine

Both engines are a four-cylinder side-valve type having a bore and stroke of 75 mm. × 120 mm., giving a capacity of 1,943·85 c.c. and an R.A.C. rating of 13·95.

The cylinder block and crankcase are formed in one casting, thereby providing additional stiffness and preventing any possibility of trouble through misalignment.

Engine and gearbox are combined as one unit—the clutch, which is a 9-in. single dry plate, Borg & Beck type—being enclosed in an aluminium housing uniting the two.

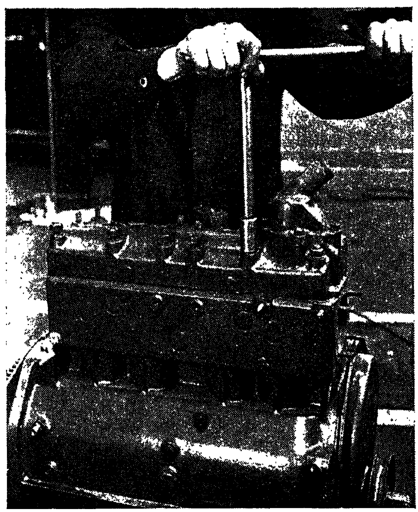


Fig. 6.—ENGINE OVERHAUL
Showing removal of head on 15-cwt. and type N1, 75–110 mm.

Decarbonising and Valve Grinding

To remove the cylinder head, first drain radiator and disconnect top hose, then uncouple ignition wires and take off distributor. Head nuts can now be undone and the head lifted off.

On the early engine, lugs are provided at the ends of the head to enable it to be freed from the block and gasket ; on the later engine, however, the gasket is

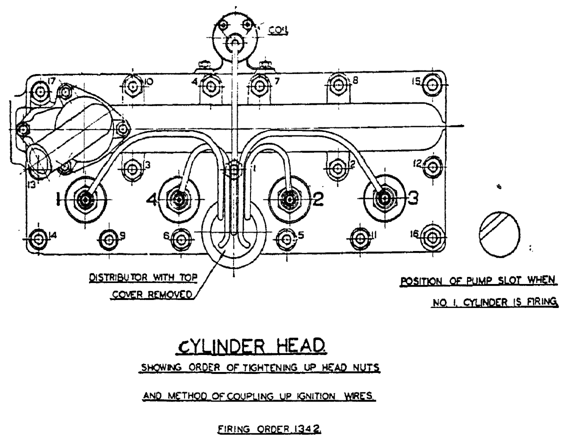


Fig. 7.—CYLINDER HEAD OF 15-CWT. AND N1 MODELS (LATEST TYPE)

cut away in three places to allow insertion of a screwdriver or wedge. Great care must be taken when carrying out this operation not to insert the screwdriver or wedge too far, and also to be sure that the correct positions have been found. It is also inadvisable to withdraw distributor driving shaft.

Tappet adjustment and work on the valves is greatly facilitated by first removing the carburettor from the manifold to give easy accessibility.

On the first type of engine the tappets are carried in two blocks, and removal of these makes it easier to get at the cotters, but if this is done, it is advisable to cover the camshaft, as if any parts are dropped they are difficult to retrieve.

Inlet and exhaust valves have heads of different sizes and must not be interchanged—the diameters are: inlet 35 mm. and exhaust 33 mm.

On later engines, exhaust-valve inserts are fitted, and in cases where standard is not a good fit, can be obtained in oversizes of ·002 in. and ·010 in. They can easily be chipped out and new ones pressed in, the block then being peened over.

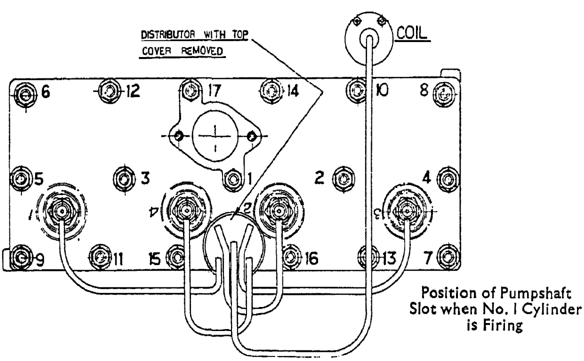


Fig. 8.—CYLINDER HEAD OF 15-CWT. AND N1 MODELS (OLD TYPE)
Showing order of tightening up head nuts and method of coupling up ignition wires.

It is of primary importance that the gasket, which is marked, should be replaced the correct way up and the head nuts tightened in the order

shown on the illustrations.

Fig. 8 is applicable to the earlier type of engine and Fig. 7 to the later. The illustrations can easily be associated to their respective engines by the position of the water pipes.

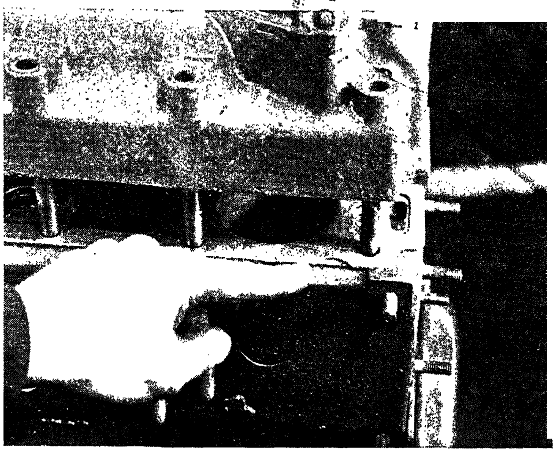


Fig. 9.—REMOVING CYLINDER HEAD (15-CWT. AND TYPE N1 ENGINE)

Pointing to slot provided for screwdriver for easy removal of head on this type engine.

Valve-tappet clearances should be set with a cold engine and differ between the early and later types as follows :—

	Early Engine	Later Engine
Inlet	·010 in.	·010 in.
Exhaust . . .	·015 in.	·012 in.

Here, again, the illustrations will assist in identifying the engine being dealt with.

Ignition Timing

Ignition is by coil and distributor, manual plus centrifugal advance and retard being employed on the first type of engine, the later models being fitted with suction and centrifugal control. In both cases the centrifugal mechanism, which is totally enclosed in the distributor itself, is utilised for control at the higher engine speeds.

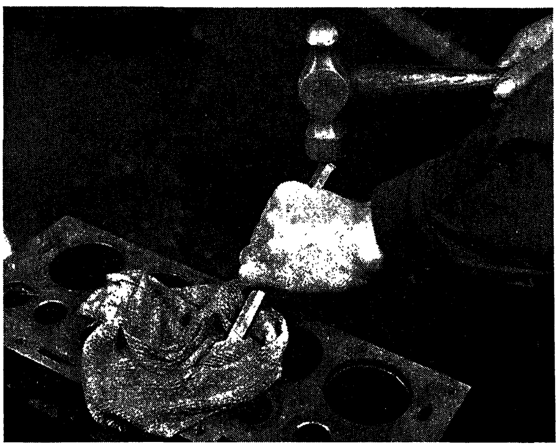


Fig. 10.—REMOVING VALVE INSERT

Cloth is to prevent danger of flying chips of steel.

The distributor is mounted on top of the cylinder head

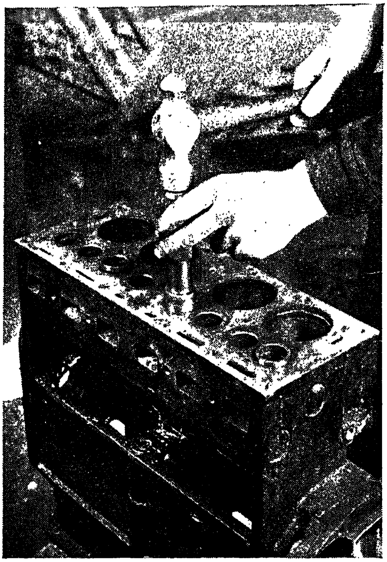


Fig. 11.—FITTING NEW EXHAUST VALVE INSERT BY MEANS OF DRIFT TOOL

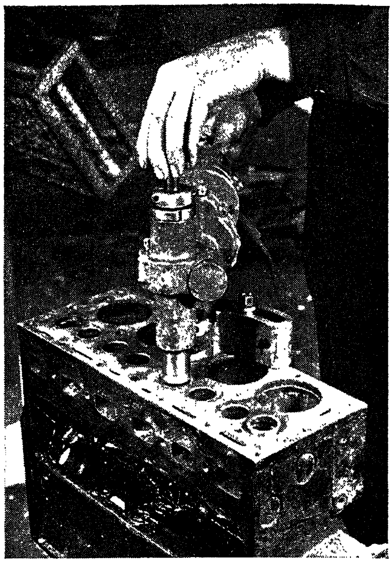


Fig. 12.—GRINDING VALVE SEAT OF INSERT

and is driven from the camshaft by means of a vertical shaft which also drives the oil pump. It will be noted that the coupling between the driving shaft and the distributor is so constructed that the distributor cannot be fitted incorrectly.

Correct ignition timing is top dead centre with both controls fully retarded.

To obtain "top dead," rotate flywheel until both valves of No. 1 cylinder are closed and the mark 1/4 corresponds with centre of top clutch inspection hole, or on later engines until the same mark is in a similar position to a hole provided in the rear engine support plate, and which hole can be seen when looking from the front on the offside.

Now loosen clamping screw on distributor and turn body anti-clockwise, looking from the top, until contact points are just breaking and the rotating arm is pointing to left-hand bottom corner, also looking from the top and from the nearside.

Hold distributor in this position and tighten clamping bolt securely.

Firing order is 1, 3, 4, 2, and reference to the drawing of the cylinder head will show that it is marked, starting from the radiator 1, 4, 2, 3. This signifies that the distributor point nearest to the radiator is connected to the sparking plug nearest the radiator; No. 2 on the distributor (working in a clockwise direction from the top) to cylinder marked No. 2, and so on, ignoring, in all cases, the centre point, which is connected to the coil.

Early-type engines are fitted with 18-mm. plugs, and the recommended point gap is ·020 in.; on the later engines, however, 14-mm. plugs are utilised and the gap is increased to ·032 in.

Distributor rotation is anti-clockwise (viewed from driving end); contact-breaker gap recommended being ·018 in. on machines fitted with 18-mm. plugs, and ·012 in. on machines having the 14-mm. size.

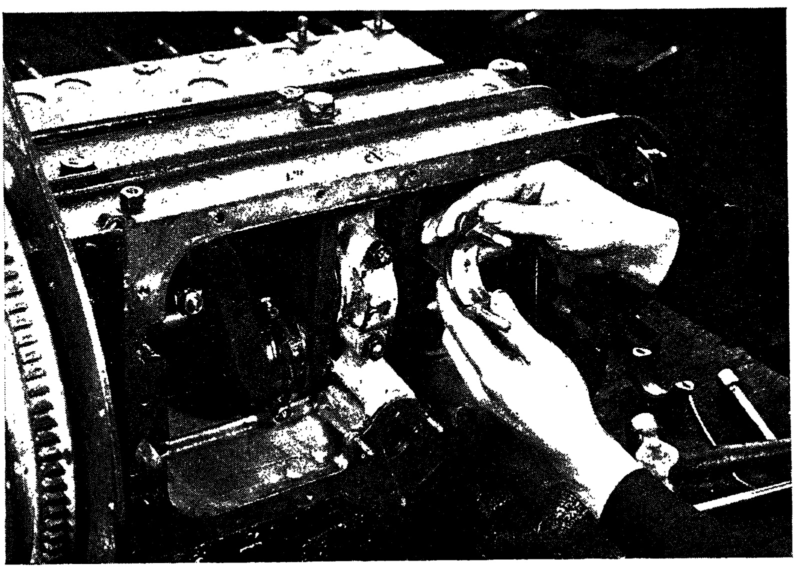
Replacing Oil Pumps

The oil pump depends into the engine sump, which must be dropped before it can be removed.

When replacing care must be taken that the distributor drive coupling is refitted in the correct position.

To do this, the engine should be set with No. 1 cylinder on the point of firing. The pump should then be entered into the cylinder block so that, looking from the nearside top, the slot in the coupling is at 45° to camshaft and the smaller crescent adjacent to the camshaft and pointing to the front, i.e. slot running from the top right-hand corner to the bottom left-hand corner. (See drawings of cylinder heads, Figs. 7 and 8.)

It is, of course, necessary to remove distributor during this operation; after replacing retime if necessary.



13.—Removal of piston and con-rod. (15-cwt. and N1 engine)

Pistons and Connecting Rods

These may be withdrawn from below if the following procedure is adopted :

Turn engine until big end to be removed is lying horizontal and against the camshaft. Free from crank and withdraw from offside of crankshaft until piston is out of cylinder bore and resting on balance-weights. Feed out by turning crankshaft in opposite direction to engine rotation, the piston coming out of the crankcase over the balance-weights.

On the early-type engine the white metal is deposited directly on to the rods, and *under no circumstances* should either rods or caps be filed to take up wear, as this will render them non-standard, and they will not be accepted by the makers in exchange for service replacements. These can be obtained by return of the worn rods plus a nominal sum to cover cost of remetalling.

Bearings on the later engine are detachable and replaceable, being strip-type white metal on steel half-shells, which are eared for location.

Both types of bearing are machined to extraordinarily fine limits, and no hand fitting is necessary or permissible. The clearances allowed are as follows :

Early engine ·0005 in. to ·0025 in.
Later engine ·001 in. to ·0025 in.

When fitting connecting rods see that the oil squirt hole for cylinder lubrication is directed to the offside.

It is, of course, an elementary rule that, except when replacements are being fitted, the rods should be replaced on the same crankpin journals from which they are removed and the same way round. Connecting-rod caps should not be interchanged.

Pistons are of cast iron, and fitted with two compression and two scraper rings. It will be noted that the two scraper rings on the later engines are different as between top ring and bottom, and they must not be interchanged.

Oversizes of both pistons and rings can be obtained from the makers + ·010 in., + ·020 in., + ·030 in., and + ·040 in. In this connection, it should be noted that dry cylinder liners are fitted to certain machines, and these can be pressed out and renewed if necessary or, alternatively, the liners themselves can be rebored, though the maximum amount permitted is ·020 in.

Further points to watch are that if liners of the "Austenitic" type are fitted, these entail the use of hardened compression rings and that, although the internal diameter of the liners has necessarily remained constant, there has been a change in the external diameter.

Pistons are refitted by reversing the process of removal given above, but clips are necessary to keep the rings in the grooves until in the bores.

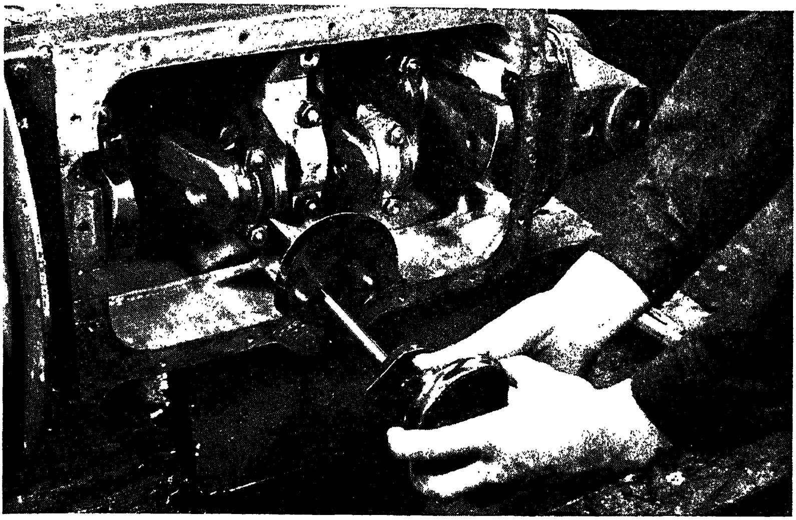


Fig. 14.—FITTING NEW MAIN BEARINGS. (N1 AND 15-CWT. ENGINE)
Having taken off sump, oil pump is removed by two nuts from studs.

Fitting New Piston Rings

When new rings are fitted they should have the following clearances :

	Early Engine.	*Later Engine.*
Gap (All rings) . . .	·003 in. to ·007 in.	·010 in. to ·014 in.
Side clearance (compression rings) . . .	·001 in. to ·003 in.	·0009 in. to ·0014 in.
Side clearance (scraper	001 in. to ·0025 in.	·001 in. to ·0025 in.

Gudgeon pins on the early-type engine are of the fully floating type held in position by circlips. The connecting rod is bushed and running clearance must be given. It is also vitally important to see that the pins are a push fit in the pistons, and on no account must force be used to insert them.

Later-type engines have the gudgeon pin nipped in the rod by means of a setscrew which, in turn, is held by a lock-washer. Movement, therefore, is in the piston, where running clearance must be given.

Oversizes of gudgeon pins for both engines are obtainable + ·0025 in. and + ·005 in.

Crankshaft and Main Bearings

There are three white-metal main bearings, and as in the case of the big ends, no hand fitting is permitted. Machined clearances allowed are

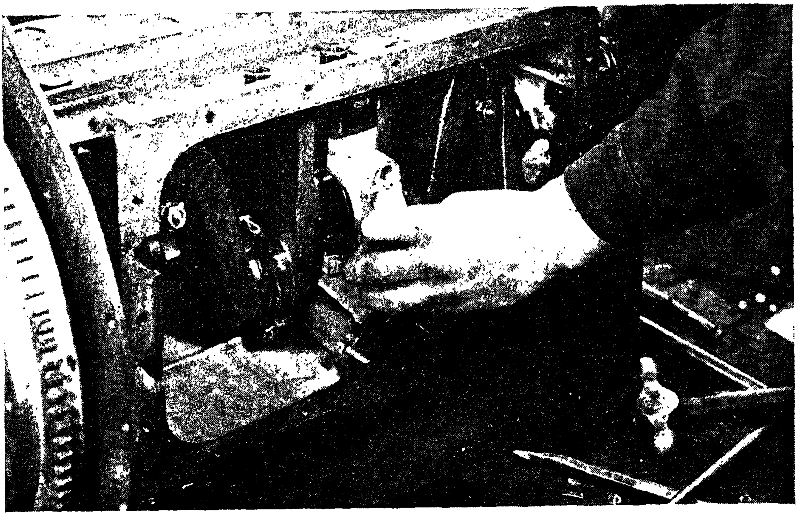


Fig. 15.—FITTING NEW MAIN BEARINGS
Withdrawing main bearing cap.

·0005 in. to ·0025 in. on the early engine and ·0015 in. to ·0035 in. on the later.

It is possible to renew the mains on the later engine by releasing the crankshaft sufficiently to allow them to be inserted, as they are eared for location and can be slid round the shaft. On the early engine the top halves are dowelled to the case and this necessitates removal of the crankshaft before renewal can be undertaken.

Crankshaft end thrust is taken on the rear main bearing itself on the early engine, but the later type has steel-backed white-metal thrust washers at either side of the rear main bearing web, these being dowelled to the cap.

Later engines have an oil-return scroll on the crankshaft, and it is important that this should not foul the case, either through misalignment when fitting new bearings or through excessive wear. If this occurs oil is bound to leak into the clutch pit.

Early engines are provided with an adaptor on the cylinder block to act as an oil retainer and the foregoing remarks apply to this also.

Correcting Water Leakage at Pump

The water pump is of the belt-driven impellor type, and the fan is setscrewed to its driving pulley. An adjustable gland is provided to correct water leakage, and when the limit of adjustment has been reached, new rings can be inserted by unscrewing the gland nut from its housing and passing the packings, which are three in number and split in order to permit the operation, over the pump spindle.

Pumps fitted to both the early and late engines are of orthodox design and the only point to watch in assembly is on the later type, on which the impellor and pulley centre are pressed on to the spindle with no other location. On this type, it is essential that both these details are a tight driving fit, and as there is no shoulder on the shaft, it is possible to drive either or both too far on to the shaft.

The impellor should be driven only until it is flush with the end of the shaft, and the pulley centre, being assembled last with the impellor and of shaft supported, should be pressed on until there is no perceptible end float but the whole assembly spins quite freely.

Adjustment of Fan and Dynamo Belt

All adjustment is made by movement of the dynamo.

On the early engine the dynamo is held to the front engine plate by three bolts, the two bottom bolts fitting in slots. Loosen the bolts and the unit will swing round the top locating bolt, tightening or slackening belt as required.

The later-type dynamo is located at the top by a lug to the crankcase and at the bottom by a slotted arm. It is necessary only to slacken the locating setscrews and swing the dynamo round the top bolt.

Valve Timing

Before attempting to time valves it is most important that the tappet clearances be increased to allow for the quieting curve on the cams.

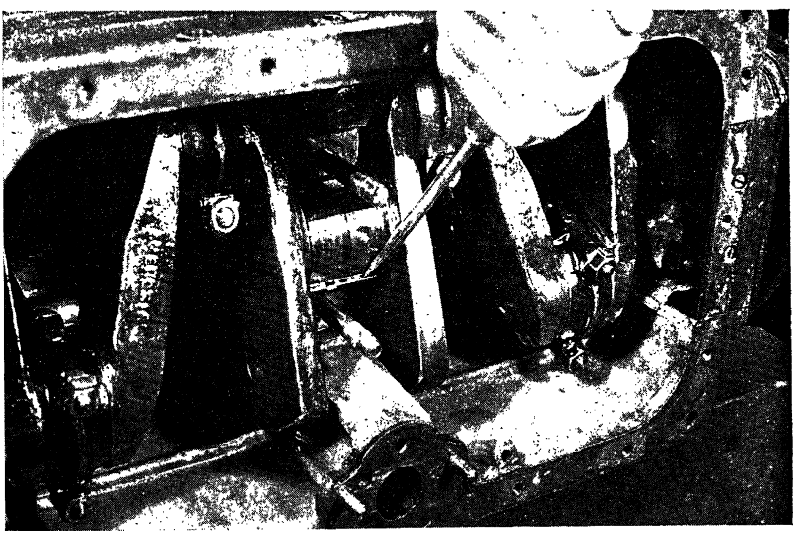


Fig. 16.—Fitting main bearing into cylinder block



Fig. 17.—FIXING NEW BEARING INTO SHELL

Clearances on the early engine should be ·018 in. and on the later ·014 in.

After the above clearances have been obtained, set No. 1 crankpin to top dead centre (instructions how to do this are given under "Ignition"), and then turn flywheel in opposite direction to engine rotation for a distance of $\frac{37}{64}$ in. (early engine) or $1\frac{13}{32}$ in. (later engine) on the flywheel periphery. To check this, piston should have moved downwards ·015 in. (early engine) or ·074 in. (later engine) from its position at top dead centre. This is the position at which the inlet valve opens.

To determine this point on the camshaft, rotate camshaft from the front in a clockwise direction until No. 1 inlet tappet can just not be turned round with the fingers.

The timing chain and wheels on the earlier engine may now be replaced, making sure that in the process neither crankshaft nor camshaft is moved. It should be explained here that as there is no provision on either early- or later-type engines for splitting the chain, and as the drive is the shortest possible with no tensioning device, the two chain wheels must be removed or refitted at the same time as the chain.

A certain amount of difficulty may be experienced on the later engine in this operation owing to the timing wheel being a tight press fit on the camshaft, on to which it cannot be drifted without the rear end of shaft being supported.

No attempt to drift the wheel on without this support must be made or serious damage will be done to the oil pump and distributor-drive gear, apart from the fact that the sealing disc fitted into the cylinder block will be disturbed and allow oil to drain into the clutch pit.

In practice, the necessity for valve timing occurs only when major overhaul is taking place, at which time it is possible to treat camshaft and its timing wheel as one unit and thereby obviate the necessity for separating these details.

Timing may be checked by rotating flywheel on exhaust stroke in direction of engine travel until T.D.C. mark on flywheel has passed this point, a distance of $1\frac{3}{16}$ in. (early engine) or $\frac{63}{64}$ in. (later engine), the

piston having moved downwards ·039 in. (early engine) or ·031 in. (later engine). This is the point at which exhaust valve closes.

It will be found that the camshaft and crankshaft chain wheels are marked, and if the timing was previously correct, it will be necessary, when fitting a new chain, only to place the markings in line. However, it is advisable to check the timing as indicated above.

After timing do not forget to set tappets to running clearances.

Oil Pressure

Engine lubrication is high pressure throughout, being at 35–40 lb. per square inch when the engine is warm at normal running speed. This may drop as low as 5–10 lb. when the engine is idling, or rise considerably higher with a cold engine.

A non-adjustable relief valve is incorporated on the offside, and should there be a sudden considerable drop in oil pressure, or if the gauge fails to give a steady reading, the trouble will probably be due to a small piece of carbon lodged under the valve.

The remedy is to remove the valve and turn engine over a few times until the oil is forced out, washing away the cause of the trouble.

Engine Temperature

On the later engines this is controlled by a thermostat fixed on the cylinder head. The thermostat is non-adjustable and will need no attention. Should trouble be experienced at any time, however, the complete unit can be withdrawn and the vehicle run without it pending repair or replacement.

It is of interest to note here that as the thermostat prevents the flow of water until working temperature has been reached, it is possible for these machines to freeze while being driven. The obvious way to prevent this trouble is to see that the engine and radiator are thoroughly warm before driving away.

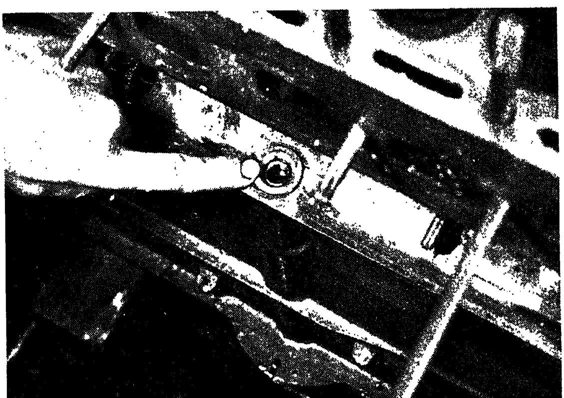


Fig. 18.—PLACING PUMP IN POSITION FOR IGNITION TIMING (15-CWT. AND N1 ENGINE)
Showing slot at 45° to camshaft.

Removing the Engine Unit

On the normal-control vehicles this is fairly simple, involving removal of radiator and

disconnection of oil, petrol, and exhaust pipes. Carburettor controls and, on the earlier engine, ignition controls also will have to be released and the electrical connections broken. It is advisable to disconnect the earth lead at the battery in order to prevent damage from shorts.

Undo propeller shaft and speedometer cable from gearbox and remove gearbox lid with its gear-change and hand-brake levers. More clearance will be obtained by taking off dynamo, starter motor, and pedal gear.

Finally, undo the three support bolts, and by means of a central lift the complete engine and gearbox unit can be removed from the frame in a forward and upward direction.

Much the same procedure is involved in this operation on the full-forward-control model, but the actual lifting from the frame prevents a certain amount of difficulty which it is suggested can best be overcome by adopting the following method.

Erect a stage at either side of the machine on which a strong round bar running through the cab can be supported. Take a purchase from this bar round the body of the gearbox and lift unit just sufficiently to clear the support brackets.

By means of a further set of tackle lift front of engine until high enough to clear cross-member. Now work unit forward through the dash, lifting as necessary. The purpose of the round bar, which will roll forward on its supporting stages, can now be appreciated.

Having reached a point where the cab prevents further forward movement of the bar, it will be found that the unit is in a position to permit a central lift being taken.

Engine Mounting

When replacing early-type engine take care to tighten up the engine mounting bolts so that they are locked in the most suitable position to enable the conical rubbers to absorb any vibration.

This position can be found only by experiment, but as a general rule satisfactory results can be obtained by tightening until it is just possible to insert a ·010-in. feeler between the coils of the Thackeray type spring washers provided under the heads of the mounting bolts. If rubbers are too tight vibration will be transmitted to the chassis ; if too loose, the whole engine and gearbox unit will tend to be very lively in the frame and lurch when cornering or braking. As the engine settles down on the rubber it may be necessary to tighten up adjustment slightly.

On later machines, although the same method of three-point mounting on rubber is employed, there is no provision for adjustment. Care must be taken to see that all mounting bolts are pulled up dead tight.

Fuel System

Fuel is drawn from the tank by an A.C. " T "-type pump and supplied to a Solex self-starting carburettor, both of these details being so well

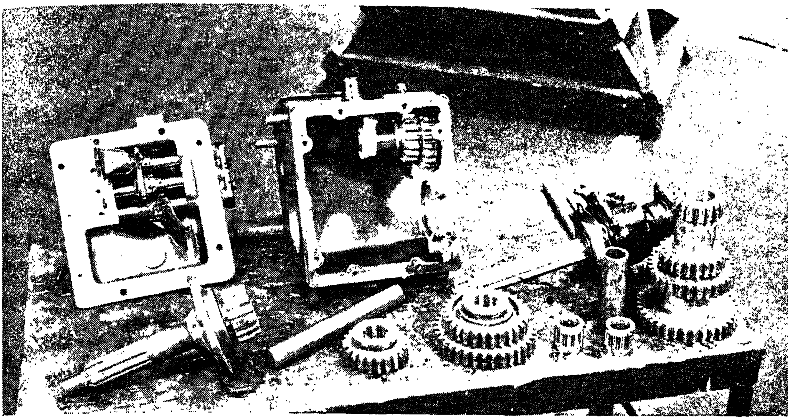


Fig. 19.—GEARBOX DISMANTLED FOR ASSEMBLY. (15-CWT. AND N1 MODELS)

known that there is no necessity for them to be dealt with here. It is necessary only to indicate that a change in these details took place when the redesigned engine came into production.

On the first engine the fuel pump was operated by a push rod, but the later, being of the "open rocker arm" type, runs directly on the camshaft.

Both carburettors are of 30-mm. size, and as previously indicated the first used was the B.F.D.V., the later being the V.B.F.D. type. While, naturally, variation in setting is necessary to compensate for particular engine characteristics, the following are found to give, in general, satisfactory results :

B.F.D.V. Carburettor

Main Jet	*Choke*	*Auxiliary Jet*	*Float*
100 × 57	23	·045	26 Gr.

Needle Valve	*Starter "G.A."*	*Starter "G.S."*
2·0 mm.	6·0	145

V.B.F.D. Carburettor

Main Jet	*Correction Jet*	*Choke*	*Auxiliary*
110	220	24	·055
Needle Valve	*Float*	*Starter "G.A."*	*Starter "G.S."*
2·0 mm.	26 Gr.	5·0	145

Difficulty may be met with in removal or replacement of the starter motor used on the early engine. This unit is located in the bell housing by a large securing bolt, which must be removed before the motor can be withdrawn. See also, when replacing, that the motor is securely held by this dowel setscrew fitting in the hole provided.

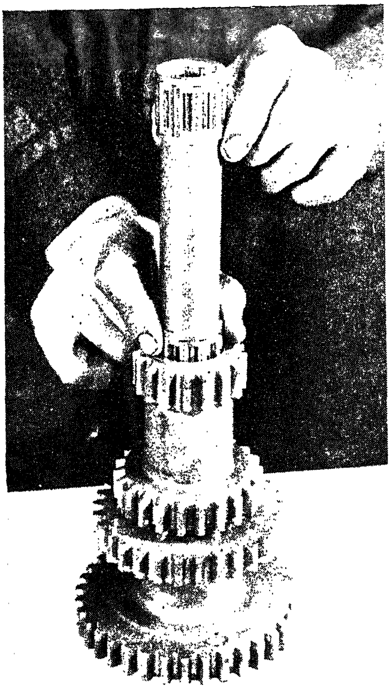


Fig. 20.—FITTING CLUSTER GEAR BEARINGS AND DISTANCE PIECE. (15-CWT. AND N1 MODELS)



Fig. 21.—FITTING CLUSTER GEAR INTO GEARBOX CASE, BY MEANS OF LEAD HAMMER OR WOODEN MALLET. (15-CWT. AND N1 MODELS)

Clutch (15-cwt. and N1 Models)

As previously indicated, this is a 9-in. single dry-plate unit of the Borg & Beck type, and it is not proposed to deal in detail with it here.

Two types have been used and are not interchangeable under any circumstances : the first employs six thrust springs and the cover is held between flywheel and starter ring ; the later has nine thrust springs and is setscrewed direct to the flywheel.

The clutch assembly itself should not be dismantled for any purpose unless the person dismantling it has made himself conversant with the correct method of both dismantling and reassembling, and the correct method of final adjustment upon reassembling. Correct internal adjustment of the clutch is essential and of the utmost importance.

Renewal of Driven Plate or its Linings

The renewal of the driven plate or its linings may be carried out without disturbing the internal adjustment, the procedure being as follows :

Remove propeller shaft, gearbox, and clutch bell housing. The two latter should be taken off together, and before doing so the rear of the engine must be propped up.

Unscrew evenly the setscrews holding starter ring (early engine) or clutch cover (later engine) to flywheel, after marking to ensure all parts are finally replaced in the same relative positions.

The clutch assembly can now be taken away, and the centre plate relined or replaced with a new one.

When replacing, smear clutch-shaft splines with a little graphite grease. The spigot bearing in the flywheel should also be packed with grease, though care should be taken not to use an excessive amount or the surplus will be flung out on to the linings, causing clutch slip.

The hub of the driven plate is chamfered, and this chamfered end should be towards the gearbox to facilitate entry of the clutch spline shaft when remounting.

Line up the clutch driven plate with the pilot bearing in the flywheel before finally tightening clutch-cover holding screws. This can be done by the introduction of a suitable mandrill or by the use of a spare clutch shaft.

Finally, *do not in any circumstances* let the gearbox hang in the clutch assembly during removal or refitting.

Pedal Adjustment

Movement of the clutch pedal beyond the point at which the clutch is released serves no useful purpose and only imposes undue stress on the internal parts of the clutch.

The clutch pedal should be adjusted so that it comes to rest at the moment that the clutch "stops," i.e. is fully disengaged and ceases to spin.

From this point to full clutch engagement the release-lever plate requires a movement of $\frac{7}{16}$ in., and this is represented by a pedal travel rearwards of $5\frac{7}{8}$ in.

Beyond this point the clutch pedal should be free to move back a further 1 in. to $1\frac{1}{2}$ in. before it comes to rest on its rearward stop in order to ensure that there is a clearance of not less than $\frac{1}{16}$ in. between the graphite-release bearing and the clutch-release lever plate.

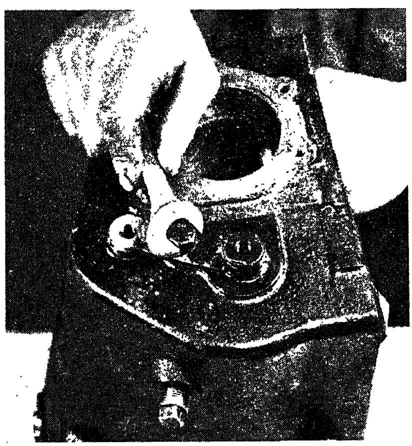


Fig. 22.—SHOWING LAYSHAFT AND REVERSE SHAFT LOCKING PLATE BEING FITTED. (15-CWT. AND N1 MODELS)

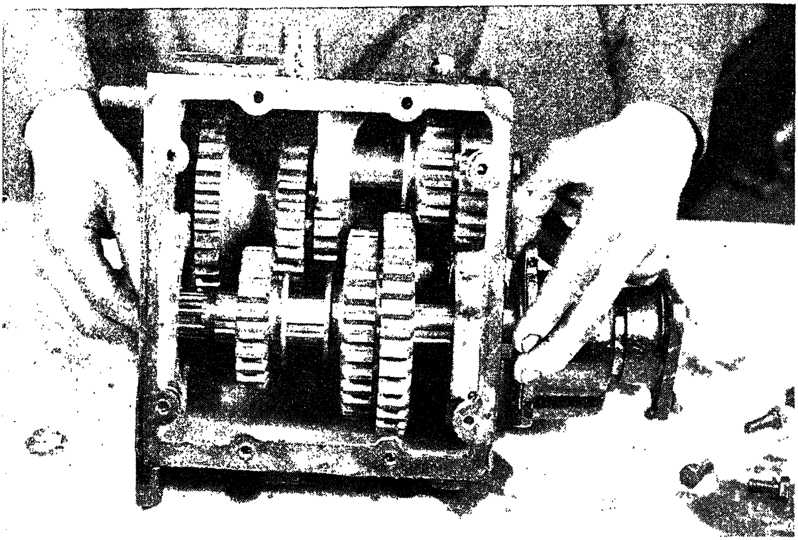


Fig. 23.—REASSEMBLING GEARBOX. (15-CWT. AND N1 MODELS)
Showing insertion of main shaft and gears.



Fig. 24.—REASSEMBLING GEARBOX. (15-CWT. AND N1 MODELS)
Pilot bearing and distance piece on mainshaft.

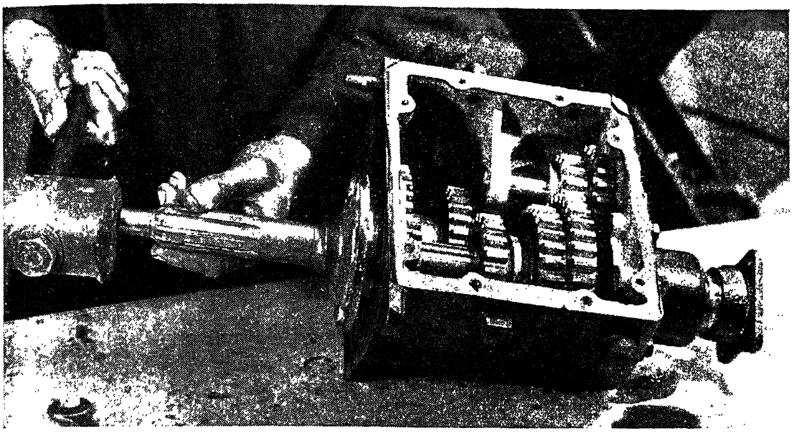


Fig. 25.—FITTING PRIMARY SHAFT AND BEARING. (15-CWT. AND N1 MODELS)

Gradual wear of the clutch linings will tend to " bring the pedal back," thereby reducing the amount of free movement. When this occurs adjustment should be made on the setscrew at the end of the clutch-operating fork—which is the only adjustment provided to compensate for wear—to restore the conditions mentioned above.

Gearbox

The four-speed gearbox, in which only straight-tooth gears are employed, is of orthodox construction and should present no difficulty in servicing.

To remove Gearbox

It is necessary only to disconnect hand-brake rod, speedometer cable, and propeller shaft. Then take off the four nuts from the setscrews holding the box to bell housing, and the unit can be withdrawn.

If resistance is felt it will be due to the ball bearing in the flywheel which supports the primary shaft being tight on the spigot. This resistance can, however, usually be easily overcome.

The observations made in the section headed "Clutch," advising application of graphite grease to the splines and the inadvisability of letting the box hang in the clutch assembly, apply when replacing gearbox.

Change-speed lever can be lifted out after the cover on top of selector tower has been unscrewed. When replacing, note that the reverse trigger is on the offside and that the lever is prevented from turning by the two slots in its ball fitting on the pegs provided in the tower. Take care when the lever is removed that these two pegs, which are a loose fit in the tower, do not fall inside the box.

The hand-brake lever is fixed on a shaft which rotates in the gearbox tower. To withdraw, take out the setscrew nearest to the hand-brake shaft holding cover to gearbox and remove unit sideways.

Top Selector Cover

Remove all setscrews holding selector cover to gearbox casing, and the cover, complete with selector rods and forks, can be lifted off the box. Striker forks are located on selector rods by dowel setscrews, and after these and rear end cover have been removed the three rods can be withdrawn.

In reassembly see that the selector shaft locating balls and their springs (three in number), together with the two locking pins—which operate between the rods to prevent more than one gear being engaged at a time—and the distance-piece—fitting in first and second selector rod between the locking pins—are not left out.

To dismantle Gearbox

Primary shaft with its ballrace may be withdrawn after removal of the front end cover, and the mainshaft, ballrace, coupling, and rear cover can be extracted as one unit when the setscrews holding rear cover to box have been taken out. The two sliding gears can be lifted out from above subsequent to removal of mainshaft. Shims are fitted between the front and rear covers and the gearbox, and these must be returned exactly as originally fitted, as they do not take up wear but serve to ensure the correct locking up of the ballraces in the casing.

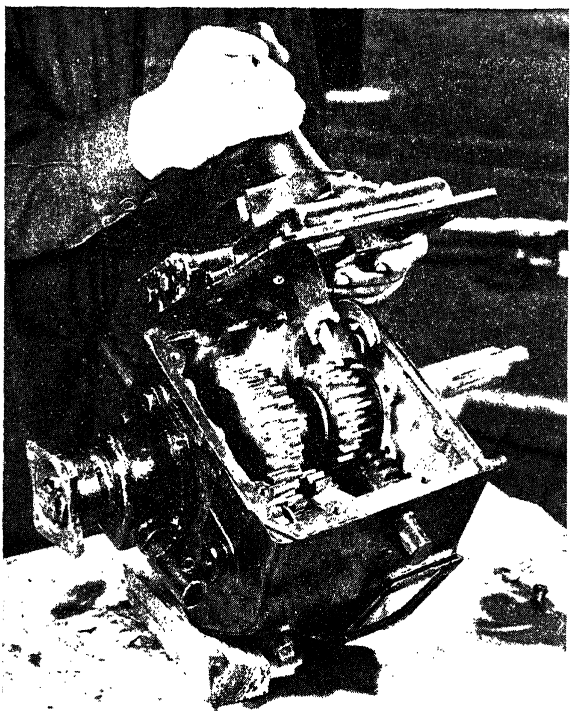


Fig. 26.—FITTING GEAR TOWER TO GEARBOX. (15-CWT. AND N1 MODELS)

Layshaft and reverse spindles are locked by a small plate on the rear face of the gearbox. When this is removed both shafts may be withdrawn, $\frac{3}{8}$ in. B.S.F. tapped holes in the end being provided to assist this withdrawal.

After withdrawing the shafts, layshaft cluster and reverse wheel can be taken out through top of box. Layshaft bearings and distance-piece come out with the layshaft cluster.

ENGINE N2, N3, N4, N5, AND LN5 MODELS

The above models of the Commer range are fitted with six-cylinder engines having a stroke of 120 mm. The N2, N3, and N4 have a bore of 75 mm. and the N5 and LN5 a bore of 85 mm.

Apart from the difference in bore diameter, giving capacities of 3180·9 c.c. and 4085·7 c.c., with R.A.C. ratings 20·92 and 26·88 respectively, the engines of the side-valve type are exactly the same in construction.

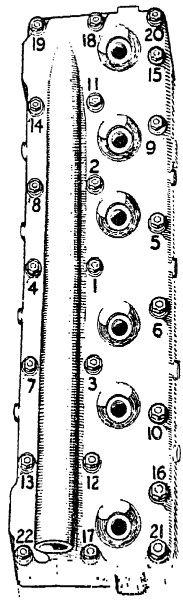


Fig. 27.—CYLINDER HEAD. (N5 AND LN5 MODELS)
Showing order of tightening nuts.

Decarbonising and Valve Grinding

Drain the radiator and cylinder block by means of the two cocks provided (one in radiator bottom pipe and one in offside of cylinder block behind oil filler and breather). Disconnect ignition wires and top water hose, remove coil, high-tension wire carrier, and head nuts.

The head can now be freed from the gasket and lifted off; lugs are cast at the ends in order to assist the removal, and it is good practice when decarbonising these engines to leave a ring of carbon about $\frac{1}{8}$ in. wide round the outside circumference of the piston top.

If work on the valves or tappet adjustment is to be carried out, accessibility is much improved by removal of carburettor from manifold, and the cotters can be got at much more easily by taking out the blocks in which the tappets run.

Should it be decided to remove the tappet blocks, always cover the camshaft with a cloth before attempting to release the cotters, for if one of these falls into the camshaft oil trough it will be difficult to recover.

Dual valve springs are fitted on the majority of engines, but a few of the earliest had only a single spring, and if any trouble is experienced it is desirable to replace these with the latest type, though this will, of course, necessitate new cups.

The valves are numbered 1 to 12 from the front, and the diameters of the heads are: exhaust valve (both engines), 35 mm.; inlet valves (75-mm.

bore), 39 mm.; inlet valve (85-mm. bore), 42 mm. It will be seen that the valves are not interchangeable. Valve-seat angle is 45° throughout.

Pressed-in exhaust-valve inserts are fitted, and can be obtained + ·002 in. and + ·010 in. It is essential that they be a good fit and that the block be peened over after insertion.

Valve guides are renewable and can be extracted either up or down, being pressed in so that there is a distance of 19 mm. between the upper face of valve chest and bottom of guide. The makers will supply an oversize of ·003 in. in order to overcome any slackness in the block.

When replacing head, tighten the head nuts in the order shown on the illustration, and see that the side of the gasket marked "Top" is uppermost.

Tappet clearances are: inlet ·008 in. and exhaust ·012 in. with the engine cold.

Valve Timing

It will be found that the camshaft and crankshaft chain wheels have punch-marks (two on camshaft wheel and one on crankshaft), and should renewal of timing chain be required it is necessary only to place the wheels so that a line drawn from the centre of camshaft to the centre of crankshaft passes between the two marks and through the single one.

The timing chain, which is of the "Duplex" endless-roller type, can easily be fitted, though it will be necessary to release the ratchet of the chain tensioner to permit sufficient slack.

Ignition timing should be checked, and corrected if necessary subsequent to the above operation.

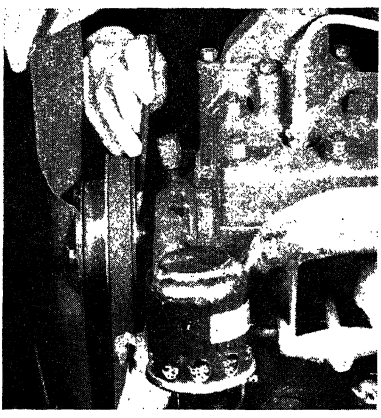


Fig. 28.—WATER PUMP. (15-CWT. AND N1 MODELS)

Rectify a water leak by adjusting gland met behind fan.

To Check Valve Timing

Valve clearances for timing are ·010 in. inlet, ·012 in. exhaust, and the following measurements will be correct only if these settings are obtained before any attempt is made to check openings, as follows:

Turn engine in direction of engine rotation with No. 1 inlet valve opening until mark $\frac{1}{6}$ on flywheel is on top dead centre. (This can be seen through the top clutch-inspection hole in the bell-housing.) Still turning in the same direction, move flywheel periphery $1\frac{3}{16}$ in., and the piston will have moved downwards ·029 in. This is the

point at which No. 1 exhaust valve closes and the tappet will just be free to revolve.

Should it be desired to time the engine without using the marks on chain wheels, the valve-opening positions are: inlet opens 5° before top dead centre, and exhaust closes 8° after top dead centre. Always reset tappets to correct clearances after timing.

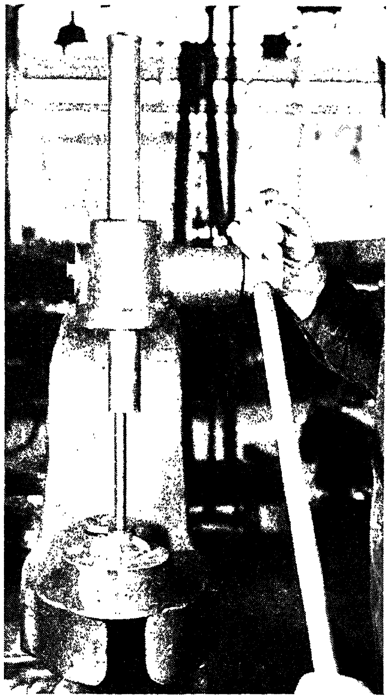


Fig. 29.—ASSEMBLING WATER PUMP AFTER OVERHAUL REQUIRES PRESSING IMPELLOR ON TO SHAFT. (15-CWT. AND N1 MODELS)

Timing Ignition

Timing is top dead centre, both controls fully retarded.

Firing order is 1, 5, 3, 6, 2, 4. When timing the distributor body should be moved in a clockwise direction when looking from the top, and care must be taken to tighten clamping screw in the locating bracket after satisfactory timing has been obtained. 18-mm. plugs are fitted, and the recommended gap is ·020 in.

Cylinder Block

Sealing discs are fitted into the cylinder block and head at various points, and can be removed to clean out the water jacket. They are of the ordinary convex type and may be removed by piercing the centre and levering out.

In replacing, it will always be necessary to use new discs and a suitable jointing compound. The recess into which they fit should be perfectly clean, in order that when they are spread by tapping the centre a perfect watertight joint be attained. The use of a suitable jointing compound is also a necessity.

Plugs of various sizes are used to close the oil galleries, and it will be unnecessary to remove any except that in the rear of block, which can be taken out to clean the main oil gallery. In this connection, care should be taken when ordering, if a replacement is required, as original engines were fitted with an ordinary plug of $\frac{3}{8}$-in. gas size and later ones had a thread with 1·5° taper. Although the plugs look very similar they are not in fact interchangeable. Any attempt to tighten a wrong plug may result in a ruined block.

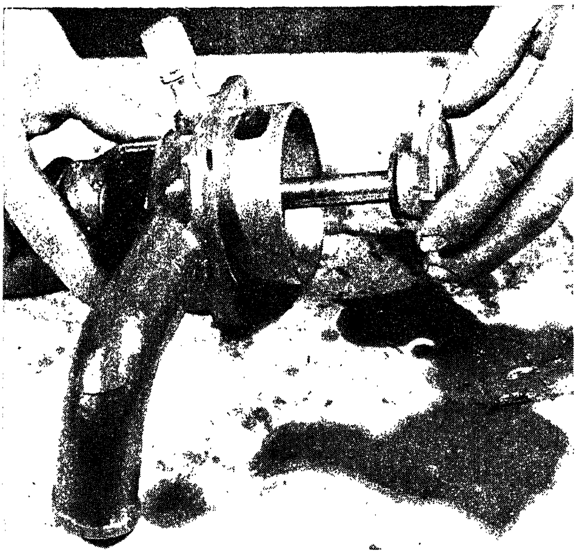


Fig. 30.—ASSEMBLING WATER PUMP (15-CWT. AND N1 MODELS)
Shaft is then inserted into body.

Oil Pressure

Oil pressure on a warm engine at ordinary running speed is 40–45 lb. per square inch, but a great variation is possible, a cold engine forcing the pressure up, while 10 lb. is perfectly safe with the engine idling.

A relief valve fitted at the nearside rear of cylinder block, acting on the oil in the main gallery, prevents excess pressure in the system and also maintains a constant pressure in normal conditions. This relief valve is of the non-adjustable type, and the only troubles likely to be experienced are weakening of the spring or carbon lodged beneath the plunger. The remedy in the first case is obvious, and in the latter follow instructions as described for type N1.

Oil Filter

A "Tecalemit"-type oil filter fitted in a housing cast on the nearside of the cylinder block is utilised, and the makers recommend that the element be renewed every 10,000 miles at least. Access to the element can be obtained by unscrewing the nut fitted at the top of filter body and lifting cover away.

The filter body has a small screwed plug in its base to assist in the regular cleaning which is essential for both body and element.

In reassembly, the filter body should be filled with engine oil in order that the normal oil pressure may be available immediately the engine starts; if this is neglected, the oil pump will have to pump sufficient oil to fill the filter body before any quantity is forced to the bearings.

The filter itself comprises, in addition to the element, a special air-release valve, and as it is possible for the whole to be wrongly assembled, the following points should be watched:

The release valve, which is in fact a small assembly incorporating a spring-loaded plate, is in the base of the filter body, and is in its turn

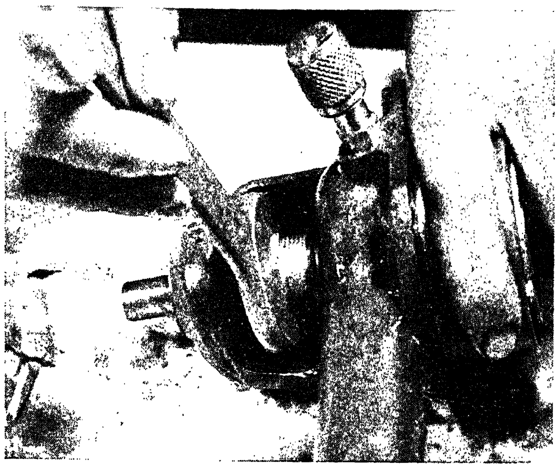


Fig. 31.—IMPELLOR GLAND NUT AND GLAND BEING FITTED TO WATER PUMP. (15-CWT. AND N1 MODELS)

spring-loaded from below, thereby being held in close contact with the element which, by this means, is forced upwards against the cap.

A clip on the centre stud holds the release-valve assembly in the filter body, and unless this clip is removed by force it is, generally speaking, impossible for either the valve assembly or its supporting conical spring to be deranged.

Should, however, the clip be removed, it will be possible to lift out both valve assembly and spring.

In reassembly, the conical spring must be replaced with its largest diameter upwards ; to reverse it will mean that the valve will be held open and the oil will pass to the engine unfiltered.

In addition, the clip should not be forced down to the full extent to which it will go, as this will not allow the spring to function correctly, that is, to lift the element and keep it in close contact with the cap.

A further point is that there is a spring incorporated in the element itself to prevent it from collapsing under pressure. As this spring could possibly hold the lower plate from fitting closely to the element, it is pushed towards one end and the element should, therefore, be replaced with this internal spring closer to the upper than the lower end.

Removing Oil Pump

The oil pump is driven by skew gear from the camshaft and is of the ordinary gear type, being held to the cylinder block by two setscrews. After removal of the sump and these two setscrews, the complete unit can be withdrawn from the cylinder block, though some small difficulty may be experienced in this operation owing to the fact that the body (which projects some way into the block) is fitted to fine limits in order to prevent loss of oil pressure. This resistance can usually be easily overcome, but, in case of exceptional difficulty, removal of the rear tappet block will permit access to the spiral drive wheel at the side of the camshaft and the use of a punch to drift the unit down.

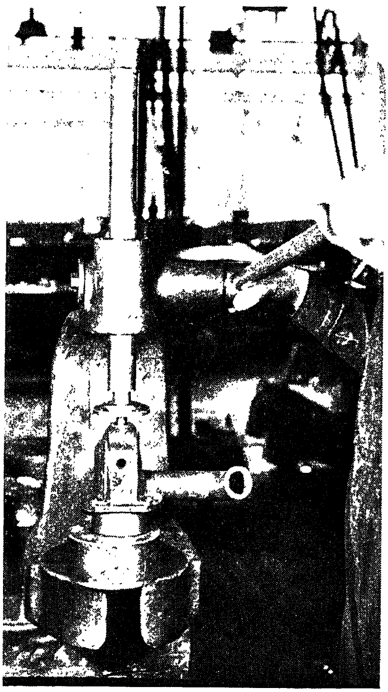


Fig. 32.—ASSEMBLING WATER PUMP. (15-CWT. AND N1 MODELS)

Fan centre being pressed on to spindle for last operation.

It is advised that this method be used only as a last resort, as it will almost certainly result in a damaged spiral wheel and may, if carelessly carried out, damage the camshaft also.

The bottom cover of the pump is an assembly from which a tube depends into the oil, and at the extremity of this tube is a large gauze bulb-type filter which can be taken off by removal of its single holding setscrew.

Four more setscrews hold the cover assembly to the pump body and removal of these will permit the cover to be taken away, when the pump wheels will be exposed.

No attempt should be made to drift the driving shaft through the gear in dismantling, as it is keyed on, and fouling of the pump body would occur. Always draw the wheel out of the bottom of the body.

Removing and dismantling Water Pump

The water pump is of the impeller type, being driven by a rubber coupling from the dynamo-armature shaft to the impeller shaft, which is extended to provide the drive.

To remove the unit after draining water, disconnect both inlet and outlet hoses, take off nut from coupling clip bolt and drive same through coupling, then release assembly from cylinder block and lift away.

Dismantle by taking out the ring of setscrews holding the impeller housing to pump body, and break apart ; all details can then be inspected.

In reassembly see that the special dowel provided to locate impeller housing correctly on pump body is in its proper position.

A gland is provided to prevent leaks, and has the usual type of adjusting nut. When the limit of adjustment has been reached, screw the nut back clear of its housing, when new gland rings (which are three in number and split to permit the operation) can be slid over the shaft without disturbing the driving coupling.

Pistons

Pistons are of cast iron with two gas and two oil rings. The oil rings fitted in the lower grooves are of different type, a knife-edge ring being fitted in the top position.

Oversizes up to ·040 in. are obtainable, and the pistons are marked on the top with the number of cylinder to which they belong, together with the information as to whether they are standard or oversize, thus " Std," " 020," etc. Clearance for fitting new pistons is ·0027 in.

On the 75-mm. engine the pistons can be removed from below after the sump has been taken off, coming down past the crank web on the side opposite to the camshaft ; but on the 85-mm. engine it will be necessary to remove the cylinder head and bring piston and connecting rod complete upward through the bores. This cannot be done on the 75-mm. engine, as the lower end of the rod is greater in diameter than the bore itself.

Clearance when new rings are fitted should be :

Gap (all rings)	·010 in. to ·014 in.
Side clearance (gas rings) . . .	·001 in. to ·003 in.
Side clearance (oil rings) . . .	·001 in. to ·0025 in.

Gudgeon Pins

Gudgeon pins are of the tube type, being hardened and ground. They run in a phosphor-bronze bush fitted in the connecting rod, in which they should be a running fit. Location in piston is by circlips, and it is advised that the pins be a good push-fit ; if they are left too tight there is a danger of piston distortion when being driven in, even though the assembly be supported during insertion.

Oversizes of ·0025 in. and ·005 in. are obtainable.

Connecting Rods

Connecting rods are of " H " section, with the white metal for big-end bearings bonded to them. The makers have instituted a system of exchange by which old rods can be returned for service replacement, and it is essential, therefore, that neither connecting rods nor caps be filed to take up wear or credit will not be allowed for them against replacement rods.

A further point is that as the bearings are accurately machined to give the allowed diametrical clearance of ·002 in., no hand fitting is required or permitted. The rods as received can be tightened up on the crankpins, though it is permitted to check end float, which should be ·004 in.

All rods are numbered 1 to 6 from the front, and must be refitted to the cylinder from which they have been removed and the same way round, as they are offset in relation to the bores.

On later engines a small squirt hole is drilled in the rods in order to project a stream of oil up the cylinder bores, and the makers have discontinued supply of the early type.

It is vitally necessary when fitting replacements to see that this squirt hole is facing the offside, with offset of rod facing the correct way.

Offset on rods for cylinders 1, 3, and 5 is towards the rear of engine, and offset on rods for 2, 4, and 6 is towards the front.

Oil under pressure is fed through a hole drilled up the centre of rod for lubrication of gudgeon pin, and if at any time new bushes are fitted care must be taken not to obscure this hole. Standard crankpin diameter is 54 mm.

Crankshaft and Main Bearings

The crankshaft is statically and dynamically balanced, balance-weights being setscrewed to the shaft. Lock-washers are fitted under the heads of these setscrews, and it is recommended a check be made during overhaul to see that the setscrews are tight and securely held by the lock-washers.

There are four main bearings, and the standard journal diameter is 65 mm.

An oil scroll is cut at the rear of the shaft and another on the fan pulley ; it is essential when fitting to see that the rear oil scroll is not fouling the crankcase, and that the one on pulley is clear of timing case. If contact is permitted oil will certainly be allowed to leak.

The starting dog, which is extended to form a setscrew, is screwed into the end of crankshaft and holds the fan pulley and timing wheel—which are keyed on to the shaft—in position.

End thrust is taken on bronze thrust washers fitted at both sides of the rear main-bearing web. Location of washers is by means of dowels to the cap. End float is ·004 in.

Main bearings are of lead bronze with steel backs, and they are eared for location. As in the case of the big ends, they are finished dead to size by the makers, and no hand fitting is permitted. The diametrical clearance allowed is ·003 in.

Bearings can be renewed with the engine in position simply by slackening bearing caps and removing each in its turn to allow the top halves of the new bearings to slide round the shaft. A strip of felt is fitted to the rear main-bearing cap, and unless it is in exceptionally good condition should be renewed each time it is disturbed.

Removing and replacing Timing Wheels and Camshaft

The camshaft is carried in four bearings ; three of these are formed in the cylinder block and the front is the only one detachable. It also is of cast iron, and, being trapped between a shoulder formed on the camshaft and the back of timing wheel, provides location. End float is ·006 in. to ·010 in.

The timing wheel, which is keyed for drive, can be drawn off shaft end after removal of its retaining nut and washer.

To remove the camshaft it is first necessary to take out the tappet block assemblies and also remove the oil pump, as previously detailed, when by undoing the setscrews holding front camshaft bearing to block the shaft can be drawn forward.

In replacing timing wheel take care not to disturb the sealing disc fitted in cylinder block to close rear bearing, or oil will leak into clutch pit.

Engine Mounting

The majority of these engines have four-point suspension, by means of two plates across the chassis, one of these being trapped between the cylinder block and timing cover and the other between the bell housing and block.

A certain number of engines, however, have three-point mounting, and in this case the plate between bell housing and block is retained, but the timing cover, which is a casting—as opposed to a pressing used with four-point suspension—has a nozzle bolted to it. This nozzle runs in a spherical bush and is supported in turn by a cross-member to the frame side-members.

In both types of mounting, dowels are used to correctly position the front engine support plates and timing covers to the cylinder block, and it is vitally important that these be returned and that locating setscrews and nuts be kept thoroughly tight.

Two special $\frac{3}{8}$-in. B.S.F. fitting bolts are used to bolt the cylinder block, rear engine-support member, and bell housing together, in addition to the ordinary ring of bolts and studs, their function being to ensure accurate alignment between engine and gearbox assembly.

If these bolts are neglected and misalignment takes place it will naturally cause rapid wear of gearbox and flywheel bearings.

The correct positions for these bolts on the various types are as follows:

N2 to LN5.—When looking from rear of the vehicle it will be found that one of these bolts is fitted in the third hole from the bottom of the bell housing on the right-hand side, the other in the fourth hole upwards from the bottom on the left-hand side.

N5.—The third hole from the bottom on the right-hand side, also looking from the rear, and the fifth hole from the bottom on the left-hand side.

The makers have traced a certain amount of trouble experienced by customers to the fact that these bolts have not been refitted after dismantling, and the importance of seeing that they are replaced is emphasised.

Removal of Engine Unit

The engine and gearbox unit can easily be removed on the normal-control vehicles when the radiator and steering gear have been taken off and the various pipes, such as petrol and exhaust, have been disconnected.

It will, of course, be necessary to undo carburettor connections, speedometer cable, and electrical wiring, together with propeller-shaft coupling bolts.

A certain amount of advantage in improved clearance will also be gained if the gearbox tower, with its change-speed and hand levers, is removed, together with the brake and clutch pedal gear, which is mounted on a shaft bolted to the bell housing. Starter motor should also be taken off and the earth lead at the battery disconnected to prevent damage to units through shorting.

A central lift on the engine will now permit the whole unit to be lifted from the frame.

There is only one point upon which doubt might occur, and that is when dealing with an engine on three-point mounting. In this case, it is advised that the front engine-supporting cross-member must be released from the frame to come out with the engine.

In connection with the forward-control type of vehicle, it will be found that much the same procedure is involved, but the pedal gear in this case is bolted to the frame and a clutch-withdrawal lever mounted on the rear engine-support plate. It will, of course, be necessary to remove these details, and in some cases the foot-brake rod passes through the rear engine support and will also have to be cleared.

The engine unit will come forward through the radiator orifice in the front dash, and the best way of taking the weight is to erect a stage at either side of the cab with a bar running from side to side from which a purchase can be taken round the gearbox. By means of an additional set of tackle lift the front end of the engine, and by working forwards and upwards at the same time edge the unit through the dash until a central lift can be obtained.

In replacement, take particular care that all engine holding-down bolts are drawn up dead tight, and in the event of the holes in the engine-support plates not lining up with the holes in the frame, draw them until the bolts can be inserted without distortion of the engine members.

Fuel System

Feed from the tank is by AC " T "-type pump, full details of which are given in Vol. IV.

A Solex V.B.F.D. carburettor is fitted, 35 mm. for N2, N3, and N4, and 40 mm. for N5 and LN5.

The following are standard jet settings, although individual variations may be made to suit special operating conditions :

	35 mm.	40 mm
Choke	28	29
Main jet	145	145
Pilot jet	055	055
Correction jet	230	220
Starter GA	6	6
Starter GS	160	175

CLUTCH AND GEARBOX (N2, N3, N4, N5, and LN5 MODELS)

Clutch

Borg & Beck clutch is standard on all models, the N5 having a 12 in. plate, the remainder being 11 in.

Movement of the clutch pedal beyond the point at which the clutch is released serves no useful purpose, and only imposes undue stress on the internal parts of the clutch. The pedal should be adjusted so that it comes to rest at the moment when the clutch "stops," i.e. is fully disengaged and ceases to spin. From this point to full clutch engagement the release lever plate on the N5 requires a movement of $\frac{1}{2}$ in., and this is represented by a pedal travel rearwards of 6 in. On the other models, the lever plate requires a movement of $\frac{7}{16}$ in., and this is represented by a pedal travel rearwards of $5\frac{1}{8}$ in.

The clutch pedal should be adjusted by means of the screw on the clutch-withdrawal lever so that there is between 1 in. and $1\frac{1}{2}$ in. free movement, in order to ensure that there is $\frac{1}{16}$-in. clearance between the graphite ring and the clutch release-lever plate.

Information on the correct methods of dismantling and reassembly of Borg & Beck clutches is given in Vol. I. In clutches with 11-in. plate the dimension from the clutch face of flywheel to the face of the release lever plate is $2\frac{5}{16}$ in. with a tolerance of plus or minus $\frac{1}{32}$ in. This dimension is useful to remember when checking the correct adjustment of the clutch assembly after new parts have been fitted, before finally mounting the clutch to the engine. Using a scribing block and surface plate, adjust each of the nuts until the release lever plate is exactly the same height all the way round its surface (i.e. so that it is true and parallel with the flywheel face and will not wobble when the clutch is revolving). This plate should lie true within ·010 in. all round.

Gearbox

On all models the gearbox carries four forward speeds and reverse—the only variation is that the N5 range has a larger stem wheel, to accommodate the splines of the 12-in clutch, and a larger rear coupling.

The box is of orthodox design, a ball-jointed gear lever operating the selector mechanism, which is carried by the lid, and can be removed as a complete unit.

The forks are retained in place on the selector rods by setscrews wired in place, and it will be noted that a locking pin slides in the middle rod to prevent engagement of two gears at the same time.

The stem wheel and mainshaft are carried on races housed in the box, a Hyatt roller bearing steadying the mainshaft in the stem wheel.

The layshaft cluster runs on roller races on a solid mainshaft, and both this and reverse shaft may be withdrawn after removing the external locking plate. Shafts are tapped $\frac{3}{8}$ in. B.S.F. to facilitate this.

To remove the box it is necessary to take it away complete with bell housing, as the setscrews securing the box are inside the housing.

Care must be taken to see that the locking wire is replaced when reassembling.

The mainshaft races are located internally by spring rings, and externally by covers secured with setscrews, oil being retained by an internal scroll on the front cover and a felt at the rear. Shims are also fitted behind these covers, and must be replaced after dismantling.

The stem wheel is drilled and fitted with a metering jet in order to lubricate the splines, and no attempt should be made to alter the size, as excess oil will find its way on to the clutch plate and cause snatch.

When removing and refitting the box it must be fully supported at all times in order to avoid possible distortion of the clutch plate.

The handbrake lever is carried on the side of the gearbox and is detached after disconnecting the brake rod and ratchet plate by removal of one of the setscrews holding the lid to the box.

SERVICE AND REPAIR NOTES ON GILFORD "HERA" 32/29 PASSENGER VEHICLES

THE ENGINE, CLUTCH, AND GEARBOX

By S. E. SMITH

THE Gilford " Hera " was first introduced at the end of 1933 and is totally different from its predecessor, the 168 O.T. model, which is very well known to operators of passenger vehicles. The general layout of the " Hera " is far more robust, the design being very modern, with simplicity as the keynote. As a result, it will be found that this model is very good from the mechanic's point of view as regards maintenance and overhaul. The following notes have been written from actual experience in the servicing of these vehicles.

ENGINE

The majority of the Gilford " Hera " produced were fitted with a Vulcan " Juno " engine, which was the standard fitment. There were a number of vehicles, however, which by a special arrangement were supplied fitted with the Leyland " Tiger " six-cylinder petrol engine. Information regarding this engine will be found elsewhere, and the remarks below are solely concerned with the standard " Hera " engine.

The " Hera " engine is a six-cylinder unit with side valves, the inlet valves being of the masked type. The valve tappets are accessible on the nearside of the engine for necessary adjustments. The magneto, which is the latest type of C.A.V.-Bosch model B.J.R., is mounted at the top of the timing case at the front of the engine, which provides for easy attention for inspection and adjustments. It is easily removed if required, and its position is such that it is out of the way of all surplus oil and dirt, which a magneto, in more orthodox positions, generally seems to collect.

There are two cylinder blocks of three cylinders each, and these are fitted with wet liners, which protrude into the large crankcase. Two detachable cylinder heads are fitted, one to each block. The crankshaft

is machined all over, balanced, and is fitted with seven main bearings. The main details of the engine are as follows :

Bore and stroke	110 mm. by 130 mm.
R.A.C. rating	45 h.p.
Develops 60 h.p. at . . .	1,000 r.p.m.
Develops 118 h.p. at . . .	2,750 r.p.m.

Decarbonising

As a general rule, an engine on commerical work requires decarbonising and the valves ground into their seats after every 10,000 miles of operation. The necessity for this work, however, more often than not makes itself apparent by the performance of the engine or a tendency to " pink " at the slightest load being imposed. Any mechanic with common sense can undertake this work, and the following notes give the procedure to be adopted in respect of the Gilford " Hera " engine.

Drain off water from radiator and remove the top water pipe, then dismantle the two cylinder heads by removing all securing nuts. Remove exhaust and induction manifolds complete with carburettor. Take off valve cover plates, compress valve springs by suitable valve lifters,

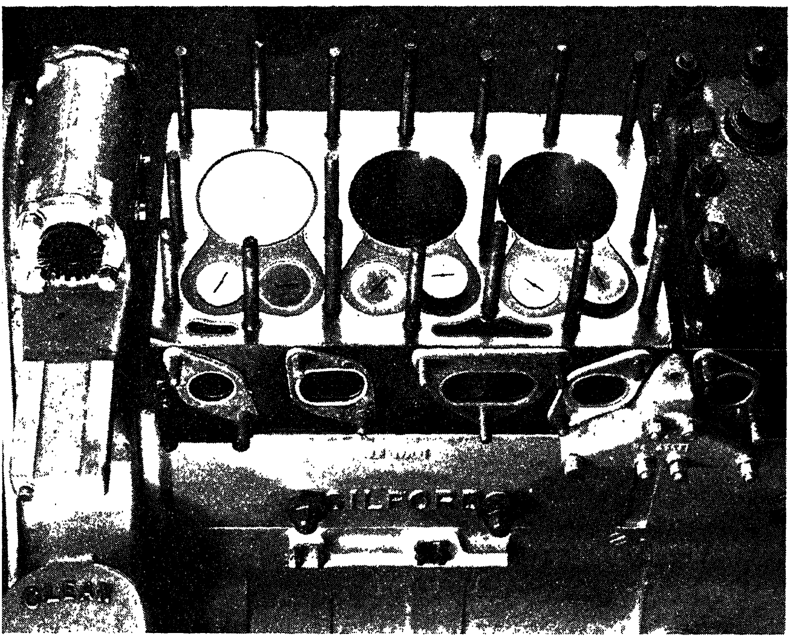


Fig. 1.—THIS SHOWS THE GILFORD "HERA" ENGINE WITH THE FRONT CYLINDER HEAD REMOVED

This illustration also shows very clearly the magneto platform and driving coupling.

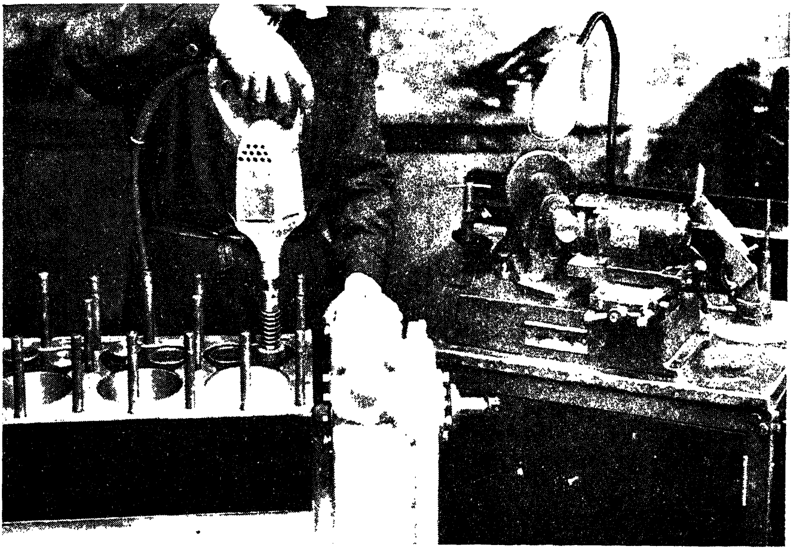


Fig. 2.—TRUEING UP VALVE SEATS ON THE " HERA " ENGINE WITH BLACK & DECKER " VIBRA CENTRIC " METHOD

This ensures accurate seatings. The valves are refaced by means of the refacing machine shown at the side of the engine.

extract cotters and remove valves, which are then free for grinding into seats.

Great care should be taken in grinding-in the valves, and it is advisable to check the seats with suitable marking composition after grinding, to ensure that they are making a perfect gastight seating before finally reassembling.

When assembling it is advisable to fit new cylinder-head gaskets and to take care in tightening down the cylinder heads. This should be done by tightening down the centre nuts first, and then from there in rotation from side to side, until the whole head is tightened down evenly and securely. After the first running of the engine and while it is warm, the cylinder-head nuts should be given a final tighten up, until they are down really hard.

Tappet Clearance

The valve-tappet clearances should also be checked again after the engine has run a hundred or so miles, and set to the correct clearances. The correct clearances are ·010 in. for inlet valve and ·012 in. for exhaust valves.

Valve Timing

In the event of the engine having been dismantled for some purpose, in reassembling it will of course become necessary to take every pre-

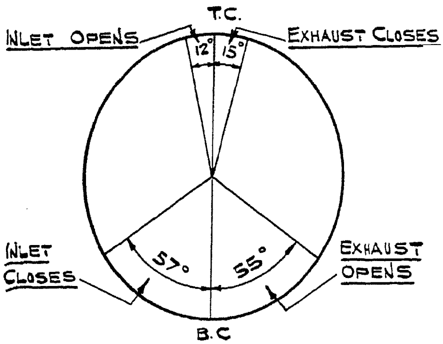


Fig. 3.—ENGINE TIMING CHART

caution to ensure that valve timing is quite correct. This is not very difficult to accomplish, but it is a matter which deserves a few remarks to those who, for the first time, have to tackle this job on the Gilford engine.

The camshaft of this engine is designed on modern lines, with what is generally described as overlapped cam contours. The actual timing of the engine is shown in Fig. 3, which indicates that the inlet valve should open 12° before top dead centre, and the exhaust valve to close 15° after top dead centre. In reassembling an engine and setting the correct valve timing it is necessary first of all to rotate the engine until Nos. 1 and 6 pistons are at top dead centre. Then revolve the camshaft slowly until No. 1 exhaust and inlet valves are just on the balance, in other words, inlet valve has started to open and exhaust valve is just about to close. At this point connect up the timing chain, after taking the precaution to make allowance for the automatic tensioner having taken up any slack which may be in the chain itself. After having done this satisfactorily, to check up that the timing is right, it is very essential to slowly turn engine back about a quarter of a turn and then to turn forward again, taking particular care to watch at the same time that the closing of the exhaust valve and the opening of the inlet valve are working in correct harmony with Nos. 1 and 6 pistons in the top-dead-centre positions. If there is any discrepancy it is a simple matter to alter the timing chain either a tooth later or earlier, whichever may appear necessary. Having quite settled this satisfactorily, the reassembling of the engine can be proceeded with without further anxiety on this point.

Timing Chains

The timing chains need no particular attention in the usual way until the time arrives when wear and slackness are so bad as to make it necessary to replace. The chains are fitted with special automatic tensioners, which take care of all ordinary slackness and also obviate rattle and the possibility of the chain jumping off the chain wheels under operating conditions (*see* Fig. 4).

These tensioners function by means of a spring-loaded ratchet, the

tension being automatically taken up a tooth at a time according to the wear that occurs.

The chains are provided with adequate lubricant, pressure sprayed by a small branch oil pipe from the front main bearing, which passes through the rear of the timing case.

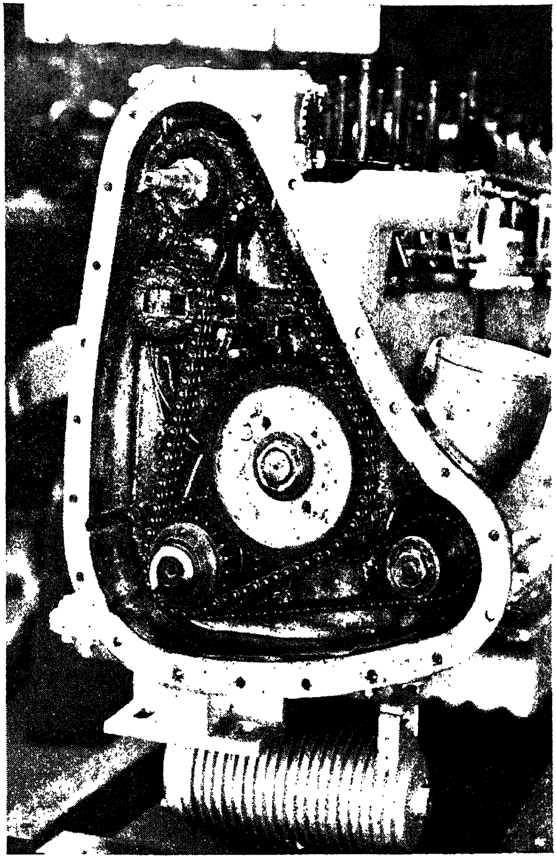


Fig. 4.—THIS SHOWS THE FRONT TIMING CASE REMOVED AND THE ARRANGEMENT OF THE TIMING CHAINS

The automatic tensioners are also visible. The ribbed cylindrical casting below the engine is the special Tecalemit oil cleaner and cooler.

Ignition Timing

The magneto fitted to the Gilford "Hera" engine is of the C.A.V.-Bosch B.J.R. type and is mounted in a very prominent position at the front of the engine. To check up the correct timing of the ignition system first remove the rear valve inspection cover plate and rotate engine until No. 6 exhaust and inlet valves are on the balance.

On top of the flywheel housing will be found a small inspection hole, through which it is possible to verify that Nos. 1 and 6 pistons are at top dead centre by the special marks on the flywheel.

Having fixed the engine in this position, which has, by the above-mentioned procedure, been double-checked firstly by the valves and then by the flywheel markings, the magneto can be attended to.

With the control fixed in a fully retarded position, the magneto should be rotated slowly in clockwise direction, as indicated by the arrow marked on the instrument itself, until the contact points are just breaking and the distributor rotor is pointing to the lead point for No. 1

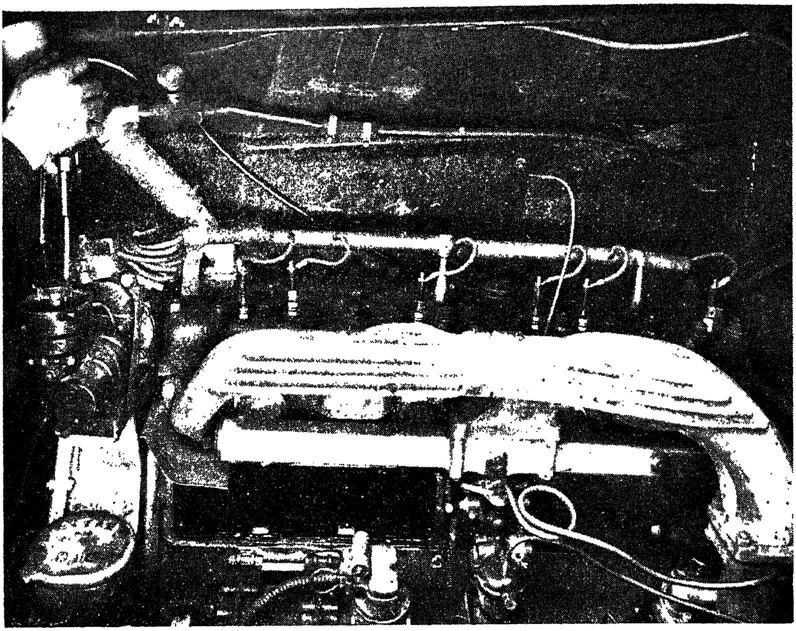


Fig. 5.—THIS SHOWS THE NEAR SIDE VIEW OF THE "HERA" ENGINE AND A MECHANIC ADJUSTING THE CONTACT POINTS OF THE MAGNETO

The magneto is situated at the front of the engine and is very conveniently placed for this operation. The front valve tappet cover is also shown removed for adjustment of tappet clearances.

cylinder. The magneto should then be clamped in this position and be set correctly.

It may be, however, after running the engine and road testing, that the performance is such that it gives rise for further attention. This can be very easily executed by means of the vernier coupling, which is easy to manipulate by the simple process of advancing or retarding by one tooth, as may be found necessary. The correct firing order is 1, 5, 3, 6, 2, 4, and the high-tension cables can be traced round according to this arrangement.

Removing Cylinder Blocks

To remove the two cylinder blocks from crankcase, disconnect the top water joint and cylinder-head nuts and remove the cylinder heads. Then take off exhaust and induction manifolds, together with carburettor ; also disconnect all water-hose joints. Remove valve-tappet covers, and it will then be found that the ½-in. cylinder-bolt nuts are available for removal. Take these off, and it will then be necessary also to dismantle the throttle rod which will be found fitted between the cylinder blocks.

It will be noticed that some of the studs are of larger diameter. These larger studs help to secure the cylinder blocks to the crankcase apart from holding the heads. These having been attended to previously, the blocks are now ready for lifting without any difficulty. Care should be taken not to damage the pistons or rings, and it is advisable to lift each block separately with a special tackle, so that they can be raised gradually without undue strain anywhere. This is all the more important because the two blocks have wet liners fitted, which protrude out of the blocks themselves into the crankcase.

Reassembling Cylinder Blocks

The method of assembly is, of course, as above with the operations reversed. When refitting blocks, always make perfectly sure that the machined faces are quite clean. Take special care not to overtighten the valve-tappet cover screws. These should be screwed home just sufficiently to make a good oiltight contact with the blocks. Too heavy a hand with a spanner on these cover screws will probably lead to a stripped thread, which is not always very easy to overcome.

Engine Removal

The removal of the engine from the "Hera" chassis is not too easy and requires very careful manipulation. It should always be withdrawn complete with gearbox, and tackled by the following procedure :

Disconnect head-lamp wires, remove the two large nuts under the radiator which secure it to its support brackets. Remove all water hoses and pin from radiator stayrod under the bonnet, and then remove radiator from chassis. The next operation is to remove the front engine suspension cross-member. First of all, take the weight of the engine in front on a suitable jack, then remove the two special bolts which hold the engine to the cross-member, and then remove the $\frac{1}{2}$-in. bolts which secure the cross-member to the chassis frame. The cross-member can now be removed. It will be found that the rear of the engine is bolted to two brackets, one on each side of the frame and flywheel housing. These bolts, therefore, should next be removed, to free the engine from its frame fixing. After this, take off all components from engine such as carburettor, dynamo, oil-indicator pipe, and magneto, etc. The exhaust pipe should be unbolted from the manifold and released from the silencer. It is not possible to remove entirely this pipe, but it will come out with the engine quite satisfactorily. The same remarks apply to the servo suction pipe.

It will now be necessary to commence dismantling on the offside of the engine. First of all, remove all floorboards in the driver's cab. Dismantle throttle rod and brackets and disconnect the clutch rod from the arm on gearbox and also from clutch pedal, by extracting the clevis pins. The brake rod should be removed in the same manner. After this, dismantle

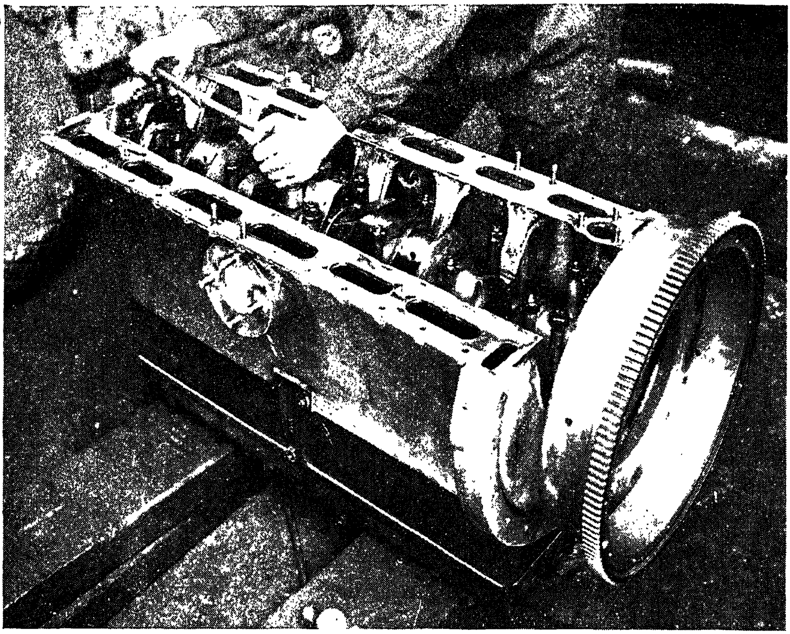


Fig. 6.—SHOWING THE METHOD OF TIGHTENING DOWN MAIN BEARING NUTS
Note that crankcase is assembled complete on to cylinder blocks for this work.

the clutch and foot-brake pedals with pedal pin from the spherical joint on gear-change lever shaft. Now dismantle the gear-change lever box from side of engine crankcase, together with the gear-change shaft, which is unbolted from a joint about half-way along, and is secured by four $\frac{5}{16}$-in. bolts. The gearbox selector box must next be removed from gearbox, and to do this it will be necessary to dismantle the selector box. The bolts which secure the selector box to the gearbox will then be exposed and can be removed to allow for the dismantling of the selector box, together with the remaining half of the gear-change shaft. All that remains now is to uncouple speedometer drive and propeller shaft from gearbox, and the engine unit is free and ready for withdrawal from chassis frame. A really good jack-type crank should be used for this purpose.

Engine Bearings

There are seven main bearings, which are all of the brass shell type. When rebedding a crankshaft with new main bearings, it is essential that the crankcase is secured to the cylinder blocks (Fig. 6). This is necessary because, if new bearings are fitted in the crankcase bare, there is likely to be some inaccuracy in alignment when the cylinder blocks are finally fitted. It is most important to see all oil ways are clear, and it is advis-

able to increase slightly the size of the oil grooves in the white-metal bearings, to ensure adequate channels for the lubricating oil. The big-end bearings are similar to the main bearings. The fitting of main bearings is an expert's job, and should never be attempted by anyone who has not had proper experience in this class of work.

Oiling System

Since the "Hera" chassis was introduced the oiling system of the engine has given rise to considerable thought. This has been due to several engines having given serious trouble with big-end bearing failures, which have largely been attributed to insufficient oil reaching them. There are, however, a large number of engines which have never given this anxiety, and if an engine is showing a good oil pressure, there is no need to worry about the oiling system at all until the time for overhaul arrives. When this opportunity occurs, it is strongly recommended that the oiling system be modified to really obviate any possibility of trouble occurring in the future. The original oiling system was controlled by two oil pumps, the main pump being situated at the rear end of the sump. This is driven by a spindle and skew gear fitted to the camshaft. The second pump, which incidentally is called the scavenger pump, is mounted immediately below the main oil pump and is driven by an extension from this pump, the connection being of the male and female type. The original system is designed for the scavenger or lower pump to force oil from the engine sump, via a special external Tecalemit-type oil cooler and cleaner, and then, still under pressure, through pipes direct to the main oil pump and thence distributed to all the vital parts of the engine. This system has certain disadvantages, the most serious being that if the scavenger pump failed, the result would be that no oil would be fed to the engine whatsoever, with, of course, probably very serious consequences. To deal with this contingency, therefore, a modification has been effected so that the oil is now returned from the filter into the sump and is then picked up from there to the main pump by means of an orthodox suction pipe. The oil is distributed from this main pump by a main gallery pipe to the seven main bearings, and from these, under pressure, the oil is forced through the crankshaft to the big-end bearings. The top halves of the main bearings are drilled with a $\frac{3}{8}$-in. hole, which coincides with a hole in the crankcase so as to provide for oil to reach the camshaft bearings. Furthermore, there is also another feed from the main oil-pump housing itself, which goes to the camshaft. This, very briefly, is the standard system as originally designed and which is quite satisfactory providing everything is in good order.

Ensuring that Bearings receive Adequate Lubrication

Experience has shown, however, that with worn main and big-end bearings, pressure very quickly drops, and the big ends, being the last to

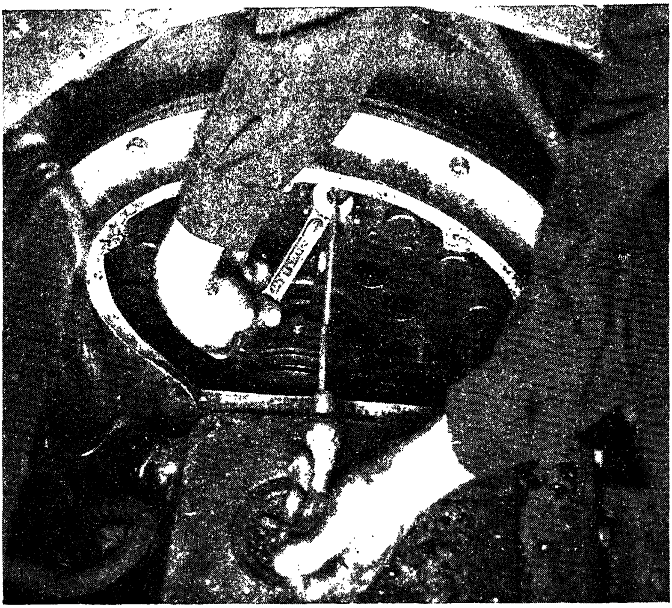


Fig. 7.—THIS SHOWS THE CLUTCH INSPECTION COVER REMOVED AND THE METHOD OF ADJUSTMENT FOR PROPER CLEARANCE OF THE CLUTCH TOGGLE LEVERS

receive the oil, naturally suffer in these circumstances. Those concerned with the servicing and repair of these engines have, as a result, had to be certain, when dealing with troubles of this kind, that the bearings really do get oil and that suitable pressure is maintained to ensure that they do not tend to overheat. This has been done mainly by eliminating the oil feed through the camshaft, which is unnecessary because this part has been found to receive adequate lubrication from other sources. Furthermore, the oil having to travel round the engine in this manner loses some of its pressure. Briefly, what is being done is to concentrate the oil pressure almost entirely to the crankshaft bearings, which, after all, is the most important matter. To do this, all the holes in the top halves of the main bearings are blanked off entirely so as to obviate this outlet for pressure. Furthermore, the $\frac{3}{8}$-in. feed hole from the oil-pump housing to the camshaft is plugged, and in its place a $\frac{1}{8}$-in. hole is drilled, which is all that is necessary. The main distributing gallery pipe is still retained, but it will be found by the aforementioned modifications that the bearings will receive adequate oil and that a greater pressure is maintained. This system has been adopted on a number of engines with every satisfaction. The oil pressure should be at least 30 lb. at 30 m.p.h.

Overhauling Oil Pumps

When overhauling the oil pumps and reassembling to engine, great care must be exercised in assembling the lower pump correctly in line with the main pump. Should the drive of these two units be at all out of line, there is a danger of the drive shearing off and thereby causing serious damage.

Pistons

These are made from aluminium alloy and incorporate a split skirt of popular design. When fitting gudgeon pins, which are of the fully floating type, the pistons should be heated so that sufficient expansion takes place to enable the pins to be pressed in by hand. Under no circumstances should gudgeon pins be driven into the piston when cold, as this may seriously affect the clearance fit of the pins in the piston bosses. The most satisfactory method of heating up the pistons is to place them in hot water for a few minutes. This ensures an even flow of expansion.

Overhauling Water Pump

The water pump is fitted at the side of the engine in a very accessible position, and is driven direct in line with the dynamo. It is of the latest carbon-seat type with no orthodox packing gland, so there are no adjustments to worry over with this unit.

When reconditioning a carbon-seat-type water pump, particular care

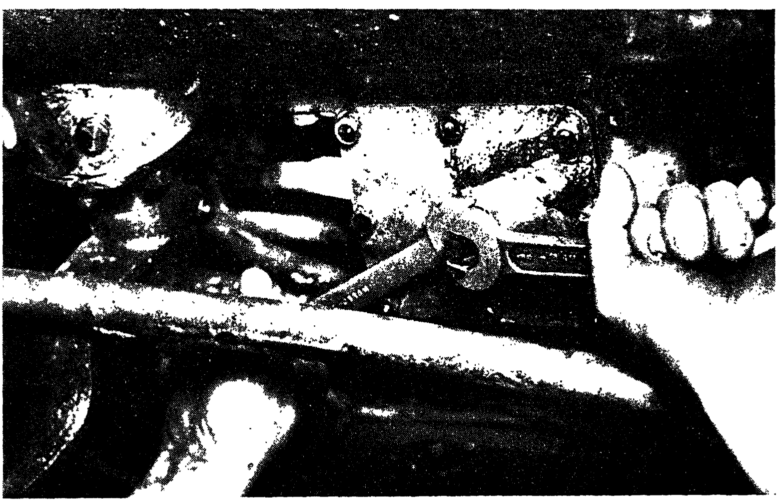


Fig. 8.—THE SPECIAL ADJUSTING SCREW FOR ENSURING CORRECT OPERATION OF THE GEAR-BOX SELECTOR GEAR

must be taken, in reassembling, to ensure that the carbon gland is making a perfect seat. If this is not done efficiently, the pump will most certainly leak.

The most satisfactory way to do this is to grind the carbon into its contact face with a paste formed of flowers of sulphur and water. It is very unwise to use carborundum paste, as the abrasive matter contained in this is likely to become embedded in the carbon and bring about premature wear to the spindle. The grinding of this carbon seat is performed in a similar manner to that in grinding valves.

GEARBOX AND CLUTCH

There is a considerable difference between the gearbox and clutch as fitted to the vehicles with the standard "Juno" engine and the Leyland "Tiger" engine. The standard units are much larger, the clutch having a greater friction area, and also the gearbox has much larger diameter gears.

With the Leyland engine the gearbox fitted is of Meadows design and manufacture, whereas with the standard engine the gearbox and clutch are units specially designed in conjunction with the engine.

The following notes are in respect of the standard type of gearbox and clutch.

Clutch

The type of clutch fitted to the Gilford "Hera" is a large single-plate type unit of orthodox design. In the event of clutch slip or any other defects with this unit, an inspection should be made by removing the inspection cover at the front end of the clutch housing (*see* Fig. 7). The clutch-withdrawal levers will then be seen and should be checked to ensure they are all set evenly. These must be adjusted in such a manner that each lever can be rocked slightly by hand. To make sure each lever is set evenly with the others it is recommended that a feeler be used to verify that the clearance is the same all round. In the event of any discrepancy being located, this can be easily remedied by slackening off the locknut, which will be noticed on the toggle-lever adjustment screws, and then resecuring this nut after whatever adjustment is found necessary. Clutch slip can often be caused by excessive oil having penetrated on to the friction discs. This should be removed by thoroughly washing with petrol.

Clutch Pedal

It is essential that 1-in. backlash is always maintained on the clutch pedal. This can be dealt with if necessary by a simple adjustment on the clutch-pedal rod.

Clutch Stop

The clutch stop is effected by means of a friction ring which is fitted to the face of the clutch-withdrawal housing. When the clutch is thrown out this disc comes into contact with a steel disc mounted on the clutch shaft itself, thereby stopping the revolution of this shaft. The correct setting for the clutch stops is for a clearance of approximately $\frac{1}{2}$-in. between the two friction surfaces.

Gearbox (Standard)

The standard gearbox is a very massive affair, the shafts being of very large diameter, rigidly mounted. The gears are of the hardened and ground type and are extremely quiet in operation. The width of the teeth is $1\frac{1}{8}$ in., which will indicate the margin of strength allowed for in the design of this unit.

There are no adjustments on the sliding and fixed shafts in the gearbox, as these are positively mounted on very robust ball-and-roller bearings which, providing adequate lubrication is maintained, give no trouble at all.

Gears Jumping Out of Mesh

The only difficulty likely to occur with this unit is in regard to the selector gear being at fault and allowing the gears to jump out of mesh. This can be generally overcome by fitting a washer under the springs in the poppet plungers to give more tension. Another possible reason for gears jumping out of mesh may be due to the slots in the selector shaft being excessively worn, in which case the only remedy is, of course, the fitment of a new selector shaft. There is a further adjustment in connection with the selector gear, and that is by a special bolt at the side of the gearbox. This should never be interfered with in the usual way, as this adjustment is set when the vehicle is new, so as to provide for the correct meshing of the gears. In the event, however, of this being disturbed, the only way to ensure the correct adjustment is to jack the vehicle up on the rear wheels. Start up the engine and endeavour to engage the gears. Should the gears not make an easy change, this special adjusting bolt should be manipulated until the required results are obtained (Fig. 8). There is no set position for this adjustment, and it can be made only by trying different settings until the changing of the gears is made without difficulty.

Removal of Gearbox and Clutch Assembly

To disconnect and remove the gearbox and clutch assembly it is first necessary to remove the bolts from the universal coupling at the rear of the gearbox. Then remove the four $\frac{9}{16}$-in. bolts which secure the centre carrier to the centre-carrier cross-shaft, and next uncouple the rear Hardy Spicer coupling from differential flange, and the whole transmission line can then be removed from the chassis.

The next procedure is to disconnect the battery and remove the self-starter which is bolted to the nearside of the gearbox housing. The split gear-change shaft should now be disconnected at the flanged joint, where it is secured by four $\frac{5}{16}$-in. bolts, and then remove the clutch pedal-shaft clevis pin. Dismantle the clutch oil pipe at the side of the gearbox, and also the oil pipe inside the housing which feeds the clutch-withdrawal race. Disconnect speedometer cable from the gearbox and undo all the bolts which secure the gearbox to the flywheel housing, when the gearbox unit can be drawn back and removed from the chassis.

To dismantle the clutch is then a simple procedure ; merely remove the bolts which hold the clutch pressure plate to flywheel, and the clutch assembly is free for removal.

REPAIR NOTES ON VAUXHALL CARS

THE ENGINE AND GEARBOX

VAUXHALL 10-FOUR AND 12-FOUR

Oil-pressure Warning Device

AN electrical warning device indicates if the pressure is dangerously low. This consists of a small self-contained switch unit screwed into a connection in the feed pipe leading from the crankcase to the A.C. oil filter, and communicating direct with the main oil feed gallery. A wire connects the switch to a warning signal placed on the left-hand side of the instrument panel, and is wired up in circuit with the ignition switch. When the ignition is switched on, the oil-pressure warning signal lights up, but as soon as the engine is started and pressure generated in the oil system, a contact in the switch unit is broken and the signal is extinguished. Should the pressure fall below a predetermined point (8–10 lb. per square inch) whilst the engine is running, the warning device is illuminated, thus attracting the driver's attention.

If, for any reason, the level of oil in the sump drops to a dangerous limit, the warning signal will be illuminated under such conditions as are produced by turning a corner or upon heavy braking, when surging of the oil in the sump may partially uncover the strainer and thus cause momentary starvation. There is, therefore, a warning that the oil-level in the engine sump is low some time before the warning signal would become permanently illuminated, denoting complete starvation of the pump.

In the event of such occasions arising, it will first be necessary to check the level of oil in the sump by means of the dipper rod. If this check indicates that there is sufficient oil present to enable the pump to operate, a further check should be made before lowering the sump for examination of the pump. The cause may be a faulty indicator switch, or a short in the lead from switch to lamp. The most suitable way of checking for a defective switch is to remove the switch from the side of the crankcase and connect up to the point of insertion a pressure gauge, when, upon starting the engine, a pressure reading will be obtained on the gauge if the pump is operating. If a short in the switch to lamp lead is suspected, check by using a new length of wire.

These points will give a conclusive check on the operation of the oiling system, and should it be necessary to examine the oil pump, then the oil-regulator valve in the pump body should first be examined to determine whether it is stuck in a fully open position.

The oil-pressure warning signal and the ignition warning signal are protected by the same fuse in the distribution box.

To Remove Oil-pressure Indicator Switch

Detach the cable connection, which is held by a spring washer, plain washer, and nut to the body of the switch, and unscrew from the crankcase boss.

The oil pump is of the submerged-gear type, driven in tandem with the distributor. The operating pressure is fixed at the factory and needs no adjustment. If any defect in the engine lubrication system is suspected, a calibrated gauge—known to be correct—can be connected to the side of the crankcase after removing the oil-indicator switch. The pressure should be 30 lb. per square inch minimum at 30 m.p.h.

Oil Pump

After dismantling the pump, check for wear on the inner faces of the cover and spindle carrier, and on the end faces of the gears. Check for abnormal clearance between the pump spindle and the pump body.

If the clearances are excessive, the efficiency of the lubrication system will be impaired due to the escape of oil, with a consequent reduction in pressure. Renew the pump body or the spindle or both, according to the extent of wear. Examine the gear teeth for scores or wear. Inspect the 18-S.W.G. relief-valve spring and check for free length of $1\frac{13}{16}$ in. and rate of $15\frac{1}{2}$–$16\frac{1}{2}$ lb.

The plunger must be a free sliding fit in the bore of the housing. If the oil pipes appear to be hard or brittle, they should be annealed.

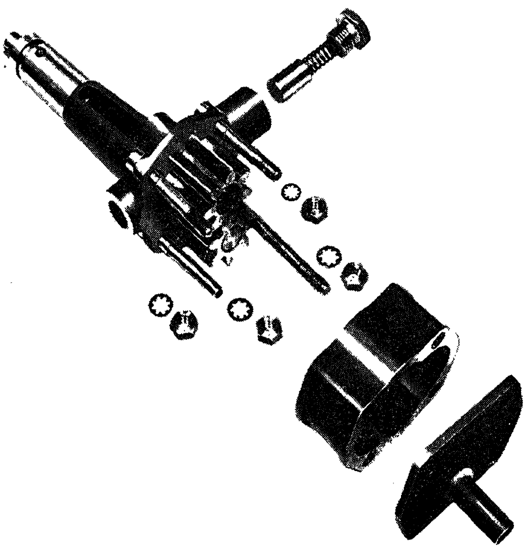


Fig. 1.—Oil pump details

Showing driving spindle dog at top, oil relief valve, idling and driving impellers, impeller body, and cover and suction pipe at bottom.

Replacing Oil Filter

The filter is clamped to the right-hand side of the crankcase by a metal strap which encircles the casing and is

attached to the crankcase by two bolts. The filtering medium is permanently enclosed in the casing, and the recommended renewal of the complete filter every 8,000 to 10,000 miles is quite a simple and inexpensive matter.

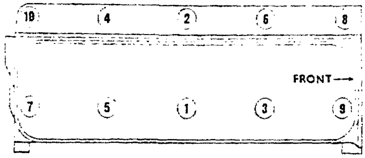


Fig. 2.—CYLINDER HEAD NUT-TIGHTENING DIAGRAM (10 H.P.)

Disconnect the two oil pipes from the top of the filter, in each case holding the union whilst unscrewing the nuts. Remove the two bolts which secure the strap to the crankcase and lift away the filter.

To test operation of the filter, disconnect the outlet pipe—the one that is off centre—when the engine is hot, and running at a speed equivalent to about 20 m.p.h. Oil should flow steadily if the filter is satisfactory. An intermittent flow of oil, i.e. drop by drop, denotes a faulty filter.

If it is found that oil is not circulating through the filter, the inlet pipe and inlet connection should be checked. These pipes may become choked owing to the use of very dirty oil. If this point is not checked, there is a possibility of connecting up the new filter with a choked pipe.

To Remove Cylinder Head

The ten nuts from the cylinder-head studs should be released evenly in the reverse order to that shown in the diagram (Fig. 2).

It may be necessary to "break" the joint with a lead hammer at either end of the head by gently tapping.

Examine all expansion plugs for water leaks. Any which show signs of leaking must be removed by drilling a hole in the plug (using grease on the drill to prevent swarf from getting into the cooling system), and then, inserting a rod into the hole, force out the plug by applying pressure obliquely.

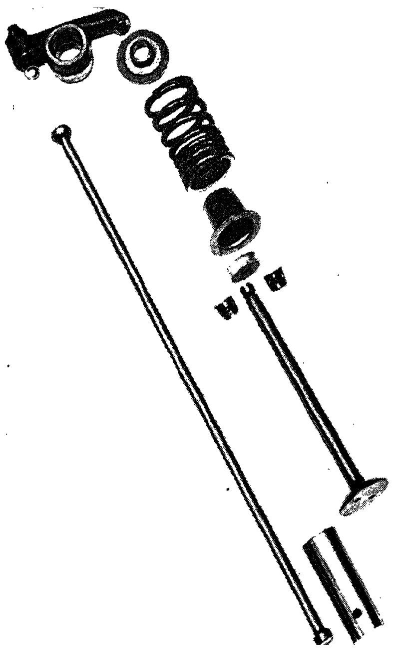
Examine the new plugs before fitting to make sure that carelessness in storage has not resulted in flats being formed in their circumference. Carefully expand in position with the aid of a suitably dimensioned drift. A jointing medium should always be used when renewing these plugs.

When replacing the head, always use a new gasket, and it is as well to lightly smear both sides with grease. The use of a jointing compound is unnecessary. Tighten the bolts gradually and evenly in the order given in the diagram (Fig. 2).

Adjusting Valve Clearance

Valve clearances should be checked and adjusted at regular intervals, as the slightest divergence from the recommended settings will affect the performance of the engine to a marked degree.

It is extremely important that the engine has reached its normal working temperature before commencing the adjustment operation, and



g. 3.—VALVE DETAILS (10 H.P.)

therefore the engine must be run for at least fifteen minutes in the shop or, preferably, the work begun immediately after a run of at least eight to ten miles.

The method of adjustment of the valve clearance follows what is now general practice. There are, however, some points of special importance, and for this reason the whole of the operations are described.

The tools required are feeler strips of ·006-in., ·008-in., ·013-in., and ·015-in. thickness, a $\frac{5}{8}$ S.A.E. spanner, and a screwdriver.

Remove the rocker cover, and if to do so the engine has been stopped, start it up and *keep it running* until the adjustment is satisfactorily finished. Adjust the carburettor throttle stop adjustment screw until the engine runs as slowly as possible. The valve clearances, which are measured between the rocker and top of the stem, can now be checked, bearing in mind that the exhaust valves must have ·013-in. clearance, and the inlet valves ·006-in. clearance. Counting from the radiator end, the exhaust valves are Nos. 1, 4, 5, 8. The inlet valves are Nos. 2, 3, 6, 7. Alterations are made by slackening back the locknut on the push-rod end of the rocker arm and turning very slightly the ball-ended screw.

After the adjustment and thorough tightening of the locknuts, make a final check on the setting, using the ·008-in. and ·015-in. feelers. If these can be inserted without force, then the adjustment operation must be repeated.

When the adjustment is completed, increase the idling speed of the engine to its original setting.

Grinding-in

Before removing the valves, number them from one to eight, commencing at the front end of the head.

Using a suitable valve-spring compressor (Britool No. 764), depress the valve springs and remove the split collars. Remove from the neck of the valves any deposits of carbon.

Grinding-in the valves will necessitate using Britool No. 983, as the valve heads have two holes for the purpose of grinding.

To Renew Valve Guides

The guides are light drive fit in the head and can be driven out and in with a suitable drift. The pilot portion of this drift should be 1 in. long and $\frac{1}{4}$-in. diameter, with a shank of $\frac{1}{2}$-in. diameter.

Examine the valve-stem oil seals and renew if not in good condition. Check the fit of the valve in the new guide before replacement. It should be free but without excessive play.

Exhaust-valve guides are counterbored $\frac{1}{2}$ in. at the lower end to prevent sticking valves. On the 12-Four model this counterbore is $\frac{1}{4}$ in.

Insert the guide from the top of the head and drive in until the top face is $\frac{53}{64}$ in. above the milled face of the head.

To Replace Valve Springs

The valve springs are of the progressive type and must be replaced with the closer coils against the cylinder head.

Warm up engine and adjust valve clearances.

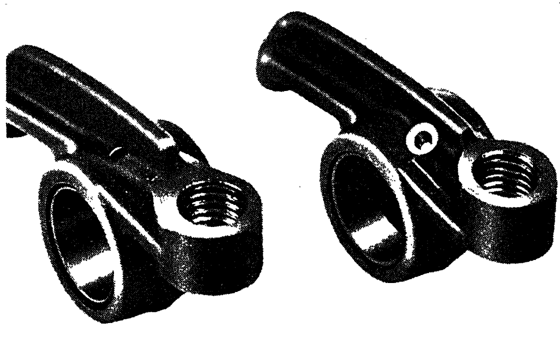
Valve-rocker Gear

On early engines it was found that the location of the oil-escape hole in the inlet rockers was such that an excessive amount of oil tended to seep down the valve guides.

From engine No. H.6200 the location and angle of drilling of the holes was altered, these being inclined more towards the push-rod end of the rocker and, in addition, counterbored.

If on any job having the first type of rockers the flow of oil to the valve stems appears to be excessive, it can be rectified by fitting rockers of the latest type.

Clearance between the rockers and the shaft should not be excessive (·0025-in. maximum when new), and if necessary the rockers should be rebushed and the shafts renewed.



First type Second type

Fig. 4.—VALVE ROCKERS—SHOWING ALTERATION TO OIL HOLES

Wear on the shaft will, of course, take place only on

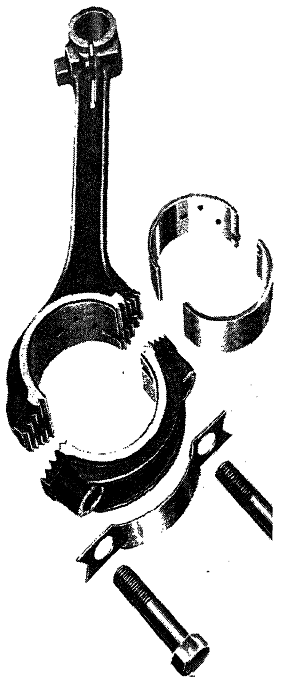


Fig. 5.—CONNECTING-ROD DETAILS (10 H.P.)

the under side. When checking for slackness, therefore, insert the feeler strip on the top side of the shaft with the rocker exactly over the area of wear.

Worn rocker tips can be rectified, if necessary, by stoning down.

To Remove Connecting Rod and Piston Assembly

Remove the sump and cylinder head, take off connecting rod caps, and withdraw piston and connecting-rod assemblies through the top of the bore. It is impossible to withdraw these downwards on account of the lack of space between the crankshaft throws and the crankcase.

To ensure that the various parts are replaced correctly, the connecting-rod caps and pistons must be stamped from one to four on the side farthest from the camshaft, number one being at the front of the engine.

To Inspect and Renew

For production purposes the cylinder bores and piston dimensions are maintained within machining limits of ·002 in., and to ensure uniformity of piston clearances these limits are subdivided into eight grades of ·00025-in. tolerances.

In order to distinguish the grade in which respective cylinder bores and pistons are classified, identification letters R, TR, B, TB, Y, TY, W, TW, are used, R being the smallest and TW the largest grade, the appropriate letter or letters being stamped on the crown of the pistons and on the side face of the crankcase adjacent to the tappet chamber opposite each cylinder bore.

For service purposes the standard grades of pistons available are Y and W only, together with ·003-in., ·005-in., ·010-in., ·020-in., ·030-in., and ·040-in. oversizes, there being a machining tolerance of ·001 in. on all oversize pistons.

On the first type of piston, which is no longer serviced, both standard and oversize were fitted, so that a feeler ½ in. wide and ·0015 in. thick, inserted between the cylinder walls and the skirt of the piston diametrically opposite (i.e. at an angle of 90°) to the gudgeon-pin bosses, could be withdrawn with a pull equivalent to 10–15 lb. as measured on a spring balance.

When checking, the piston must be held so that it is at least 1 in. below the top face of the block and with the gudgeon pin in its normal relationship to the crankshaft (i.e. along the longitudinal axis of the crankcase).

The later type of piston must be fitted in accordance with the following fitting instructions, which must be carefully adhered to.

The fitting clearance between piston and cylinder bore is ·0015 in. to ·002 in. For service purposes it should be noted that the piston skirt is oval ground and is larger at the bottom than at the top; therefore the size to which the bores have to be honed must be determined by measuring the diameter of each piston at the top of the skirt immediately below the ring grooves and at right angles to the gudgeon pin, adding the fitting clearance between the piston and cylinder bore.

When a boring bar is employed it is imperative that the bores are finally hone finished, therefore during the setting of the boring-bar cutter, an allowance of ·0005 in. must be made, which has to be taken out of the bore by a hone, using only superfine or burnishing stones for this purpose.

The pistons must be finally assembled to the bores so that the slotted side of the skirt is farthest away from the camshaft.

If reboring is necessary it is imperative that oversize pistons are in the hands of the operator and that they are checked for exact size individually before machining the block. Remember also to check in that portion of the bore over which the piston travels; above or below this section will give a false reading.

Piston Rings

As the rings are manufactured to the most exacting specifications to give a far greater wall pressure than can be obtained by any other make, it is imperative to renew only with genuine Vauxhall replacements, as otherwise oiled-up spark plugs and excessive oil consumption will be experienced.

Before fitting the rings to the pistons check them in the cylinder bore to ensure that the gap between the ends of the rings is within the limits ·008/·015 in. This is very important.

Ring gaps must not be closer than ·008 *in., otherwise the rings may butt and so lose their sealing efficiency when normal engine temperature is attained.*

To make sure that the gap is not artificially increased by one end of the ring being higher or lower than the other, line it in the bore with the aid of a piston.

Note that the compression rings are marked " Top " to indicate correct fitting, also that the lower compression ring is stepped for oil economy.

Check for correct vertical clearance in the grooves. The clearances are: compression ring, ·002–·0035 in.; compression (internal step) and oil-seal rings, ·0015–·003 in.

Gudgeon Pins

If oversize pistons are fitted, the question of the gudgeon-pin fit in the piston will not arise, owing to the fact that pistons are serviced complete with correctly fitted pins. For checking purposes, however, the pins are a hand-push fit at 120° F. Gudgeon pins ·003 in. oversize can be obtained. On no account must pins be fitted to the pistons tighter than the specified limits, as this would distort the piston and probably cause seizure.

Connecting Rods

Check for parallelism and twist. The out-of-parallelism must not be more than ·002 in. No twist is allowable. In many cases special equipment will be available for making this check, but where this is not so, the following method will be found to give satisfactory results.

A surface plate, " V " block, scribing block, dial indicator, and two mandrels will be required. The mandrels must be a snug fit in the big and small ends ; place the larger mandrel into " V " blocks on a surface plate and raise the rod to a vertical position.

With the dial indicator mounted on the scribing block, take readings on the lower side of the small-end mandrel on either side of the small end, and if it is not within the limit of ·002 in., it must be corrected by setting the rod.

To check the rod for twist, lower it on its " V " blocks to a horizontal position, and again take readings on either side of the small-end mandrel.

No twist is allowable, and the rod should be corrected by setting.

The radial clearance on the crank pins should be ·0015/·003 in. The cap is located on the rod by means of corrugations ; this, combined with the fact that the detachable steel-backed white-metal liners are rather thin, makes these rods non-adjustable. However, when wear takes place and standard-size bearings are too slack, ·005-in. undersize big-end bearings are available.

When ultimately it becomes necessary to regrind the big-end journals of the crankshaft, bearings ·020 in. undersize (·50 mm.) can be obtained, and in order that the correct clearance is obtained the pins should be machined to within the following limits : crank pin, finished diameter, 1·605/1·604 in. (40·76/40·74 mm.).

To Reassemble and Replace Pistons and Rods

As the later-type pistons fitted to this model is of the slotted-skirt type, they must be assembled to the engine so that the slotted side is farthest away from the camshaft.

Assemble the piston to the connecting rods so that the cylinder-bore oil hole in the yoke of the rod is opposite to the slot in the piston, and fully tighten the small-end pinch bolts, using new lock-washers. Run the

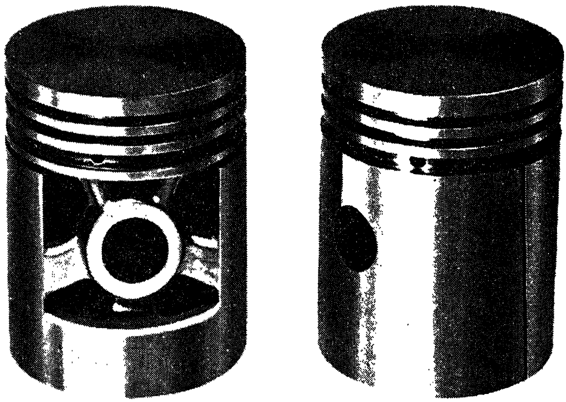


Fig. 6.—PISTONS FOR 10 H.P. FIRST AND SECOND TYPES

rings around the ring grooves of new pistons (using Britool No. 815) in order to check for clearance.

Fit the scraper ring with its gap away from the camshaft, and the two compression rings in such a way that three gaps are equally spaced around the pistons.

Fit the big-end caps with the numerals on the caps adjacent to those on the rods. Tighten up the nuts, lightly tapping the big ends either side during the process to ensure correct lining up of cap and rod.

Finally, lock the cap bolts by means of the locking plate ; replace the cylinder head and the sump.

Replacing Timing Chain

When reassembling the timing chain make sure that the timing marks on the crankshaft pinion and camshaft chain wheel are correctly positioned, as follows :

Place a small straight-edge across the centres of the crankshaft and the camshaft, and rotate these until the timing marks are parallel with the straight-edge and also directly adjacent and in line with each other.

The timing chain can then be placed in position and secured with the connecting link and U-shaped spring clip, care being taken that the latter is fitted with the legs trailing, i.e. at the rear in the direction of chain travel. Make a final check on the timing-mark setting.

Timing-cover Oil Seal

From engine No. H.2001 to H.4501, a cork seal was used, but as in some cases an oil-tight joint was not maintained the seal material was changed to felt, the latest seal being introduced at engine No. H.4502. Only the felt seal is available.

Valve Timing

The valve timing will be correct if the following conditions apply :

(1) The timing marks on the camshaft and crankshaft chain wheels must coincide at each revolution.

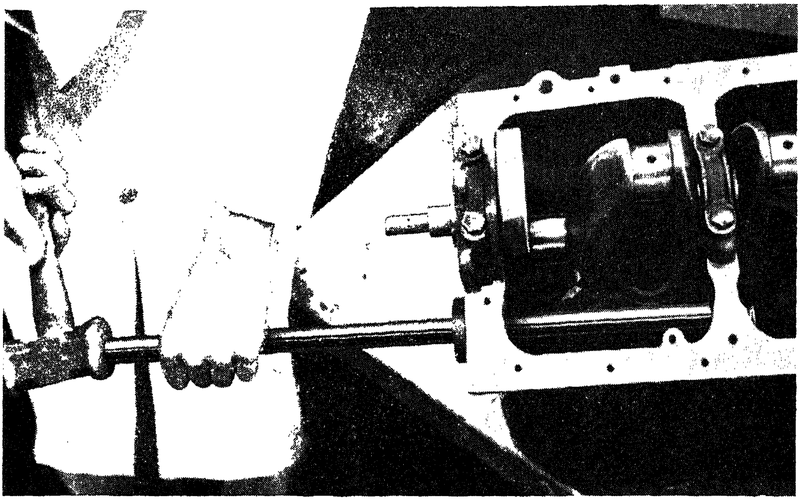


Fig. 7.—REMOVING CAMSHAFT BEARING (10 H.P.), USING BRITOOL NO. 932

(2) The keys and keyways in these wheels must be intact.

(3) The crankshaft and camshaft must be free from twist. This will certainly be the case unless either of them has received serious damage as a result of seizure or breakage of parts within the engine.

(4) Individual valve timings may, of course, be upset by wear or maladjustment in the valve-operating mechanism at some point between the cams and valves, but such a condition will be obvious on inspection of the parts concerned.

Camshaft

It is unlikely that the camshaft bearing clearance will be excessive unless knocks have been definitely traced to the camshaft. The end float of the shaft should be from ·002 in. to ·0035 in.

The bearing diametral clearance can be checked by inserting feeler strips after dropping the sump, the standard clearance being ·002 in. to ·0035 in.

Camshaft Bearings

If seizure has been caused by a choked oil way, dirty oil, or lack of oil, the bearings concerned will have to be renewed.

Special bearings having an inside diameter already finished to size are obtainable, and can be inserted in the crankcase.

See that the oil holes in the new bearings line up with the oil ways in the crankcase.

Crankshaft

The three main bearing caps can be removed by tapping *lightly* with a hammer whilst pulling the cap away from the block.

If only a small amount of wear has taken place which cannot be satisfactorily taken up by fitting new standard-size bearings, ·003-in. undersize bearings are available. If, however, the wear is excessive, the crankshaft will have to be reground or renewed.

If it is necessary to regrind the crankshaft main-bearing journals and crank pins, they should be finished to suit the ·020-in. (·50-mm.) undersize main bearings and connecting rod big-end bearings serviced by the Parts Department.

Scraping the journals is unnecessary if the shaft is ground to the following finished dimensions :

Crank pin	1·605/1·604 in.
No. 1 journal	1·730/1·729 in.
No. 2 journal	1·793/1·792 in.
No. 3 journal	1·855/1·854 in.

The shaft should be checked for alignment by supporting between centres and taking indicator readings on No. 2 journal. The production limit for this reading is ·0015 in. (·038 mm.).

When making this check on a worn shaft, allowance must be made for the possibility of the journals being out of round.

If centres are not available, "V" blocks can be used, but in this case allowance for oval journals becomes rather involved.

Checking Crankshaft Main Bearings

Due to the crankshaft bearings being located in the crankcase, it is not possible to examine the upper halves of the bearings without removing the crankshaft.

Removal of the caps, however, permits examination of the lower halves, and if these are in good condition it can reasonably be assumed that the upper halves are satisfactory. If, however, the lower halves show signs of wear or scores, the top halves should be checked, which will necessitate removal of the crankshaft. Check also for clearance, and if more than ·0025 in. it is advisable to renew the bearings, as these are not adjustable.

Flywheel Ring Gear

The T.D.C. and ignition-timing points are indicated on the flywheel assembly by means of a chisel stroke and the letters UC, and by the insertion of a small steel ball into a hole drilled at the appropriate point.

Since the commencement of production on this model the markings have undergone several detail changes affecting service, as explained in the following paragraphs.

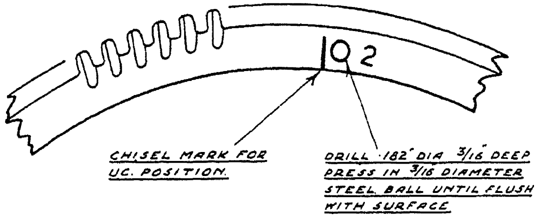


Fig. 8.—STARTER RING GEAR TIMING MARKING

Care must be taken to see that these markings are made on the side of the ring gear on which the teeth have the ends chamfered.

On engines of early production the markings appear only on the ring gear, so that it is necessary in the event of replacement to extend the marking to the flywheel face before removal of the old gear, otherwise there is no indication of the correct UC and ignition timing position when assembling the new ring gear.

Early supplies of replacement ring gears were unmarked, and in such cases the markings may be added either before or after assembly to the flywheel. To mark a ring gear before assembly it is necessary only to indicate the UC by a chisel mark (Fig. 8) placed radially in any position round the ring gear. A point is then found at a distance ·193 in. from the chisel mark on the side shown, and $\frac{15}{64}$ in. from the inner edge of the ring gear. At this position a hole ·182 in. diameter is drilled to a depth of $\frac{3}{16}$ in., and $\frac{3}{16}$-in. diameter steel ball (part No. 104916) pressed in until flush with the face of the gear. In addition, a figure 2 is stamped beside the ball, indicating an ignition setting of 2° before UC.

For the alternative method of marking the ring gear when in position on the flywheel a template conforming to the dimensions shown in Fig. 9 must be made up. Incidentally, this template will enable the correct location of the UC and ignition timing to be found should they be accidentally lost during servicing of early jobs.

The body of the template is made up from sheet steel of about $\frac{1}{16}$-in. thickness, and the marking out is done as follows :

(1) At distance $\frac{3}{4}$ in. from the widest end scribe straight line AA.

(2) With centre at mid point of AA scribe a semicircle of radius 1·8125 in., and erect a perpendicular line BB.

(3) Mark lightly with a centre-punch the three points where the semicircle cuts the straight lines. These are the positions for the dowels which locate in the flywheel bolt holes.

(4) With centre at mid point of AA, scribe an arc of radius $5\frac{17}{32}$ in. to intersect the perpendicular line BB and extend about $\frac{3}{4}$ in. to the right of the perpendicular. From this point of intersection measure off distances along the arc of ·29 in. and ·48 in. The former indicates the UC position and the latter the position for the timing-ball drilling.

At these points drill the template about $\frac{1}{16}$ in. diameter, and if the thickness of the plate warrants it, countersink slightly to facilitate the use of a scriber when the template is in use.

At the points indicated in sub-paragraph 3, drill holes $\frac{5}{16}$-in. diameter,

taking great care during this operation to prevent the drill "wandering" from the true location.

Next, three steel locating pegs must be machined to the dimensions given and attached to the template body by inserting in the $\frac{5}{16}$-in. holes and peening over sufficiently to secure them rigidly. *It is most important that these pegs are fitted so that they protrude from the opposite side of the plate when it is held with the timing mark towards the right-hand side.* If fitted the other way round, the timing and UC marks will be indicated in a position retarded from the true location.

The three locating pegs are set at angles of 90° to one another, measured at the centre of line AA. On the flywheel the remaining bolt is offset a considerable distance from the 90° angle, and in consequence the template can be fitted to the flywheel assembly in only one position.

In use, the template is located on the flywheel assembly and the positions for UC and timing marked through the $\frac{1}{16}$-in. diameter holes on to the ring gear by means of a scriber. The template is then removed and a suitable chisel mark placed radially at the position indicated, while at the point marked for the timing ball a hole is drilled and the ball fitted as described in a previous paragraph.

Due to alterations which have been made, it is possible that the ignition timing indicated by the template will not coincide with that already marked on some flywheel assemblies, but where new ring gears are fitted it will be advantageous to use the latest timing as given by using the template.

It is essential that when marking out and drilling the template the utmost care must be taken to ensure that accuracy is obtained. The locating pegs should also be a good fit in the flywheel bolt holes, as any slackness at this point will be considerably magnified at the outer end of the template.

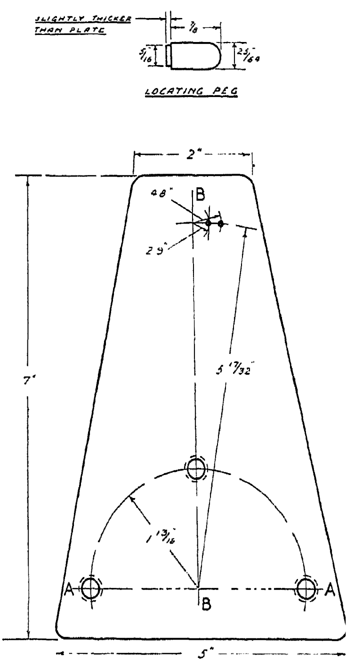


Fig. 9.—TEMPLATE FOR FLYWHEEL TIMING MARKING

To Remove

Remove the flywheel.

The ring gear can be removed by splitting it with a cold chisel, care being taken whilst doing so not to damage the faces of the flywheel to which it is shrunk.

To Replace

A shrinkage fit is relied upon to retain the ring gear to the flywheel. Gears obtained from our Parts Service Department have already been tempered to the correct degree, and it is necessary only to heat up sufficiently to drop it into position on the flywheel.

The gear must be heated to 400° C., and to determine this polish three places on one side of the ring gear with emery cloth, lay the gear with the polished spots uppermost in a furnace or oven, and watch the colours until the gear passes through the purple stage and assumes a light blue colour. If a blowlamp is the only equipment available, lay the gear on either a sheet of asbestos or a suitable iron plate and heat *evenly* to give the light blue colour. The ring must now be maintained at this temperature for five minutes, and it is important that the gear must not be raised above this temperature or the effect of the original heat treatment will be destroyed.

At the end of this period remove any scale from the faces of the gear and drop it rapidly into position on the flywheel with the chamfered side of the teeth uppermost. If necessary, gently tap the gear home with a copper hammer and allow to cool in air.

The blowlamp method of fitting ring gears is not recommended, but the information is given in an endeavour to assist in those few cases where correct equipment is not available.

Petrol System

The Carburettor Jet Settings of 10-h.p. cars which have been found most suitable for prevailing conditions in the British Isles are :

ZENITH DOWN-DRAUGHT CARBURETTOR, MODEL 30 V.I.G.

	*Up to engine No. H.*1529	*From Engine No. H.*10530
Choke-tube diameter	25 mm.	25 mm.
Main jet	85	75
Compensating jet	70	90
Slow-running jet	50	50
Pump jet	60	60
Progression drilling	1·1 mm.	1·1 mm.
Needle-seat diameter	1·5 mm.	1·5 mm.
Air-bleed full throttle	1·0 mm.	1·5 mm.

On some jobs having the earlier jet setting, a 90 main jet was found necessary to eliminate flat spots, and in such cases this jet should be retained, as no advantage will be gained by making an alteration to the jet setting.

The jet settings are the same for 10-Four and 12-Four Carburettors, but they are not interchangeable, owing to variations in the internal drilling.

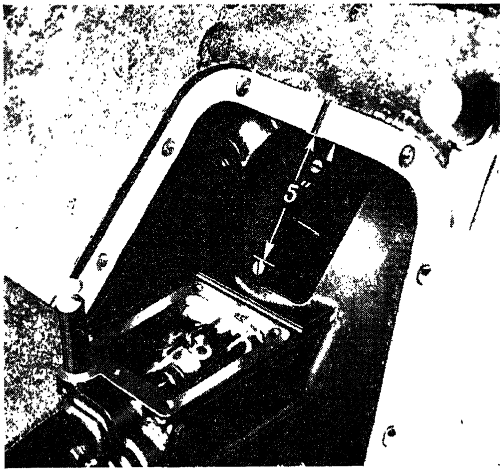


Fig. 10.—GEARBOX READY FOR REMOVAL (10 H.P.)

Shoulder Water Pump

The water-pump shaft is supplied as an assembly with bearings and pulley flange. The face of the pulley flange must be true within ·004-in. run out. Examine the rubber seal and fibre pad and renew if necessary.

When reassembling the rotor it is essential that this be pressed on to give a clearance of ·013/·032 in. between the vanes on its front face and the pump housing. This can be checked by means of a feeler gauge.

Ensure that rubber seal is fitted correctly—i.e. with the large inside diameter to the front of the pump body and the fibre seal with the chamfer to the rear of the body. Fit a new gasket between the rear of the pump and the plate.

Removing Gearbox

When disengaging the gearbox from the chassis, remove these parts in the following order:

Gearbox and universal joint cover, speedometer drive, and the eight bolts (four at each end) which secure the propeller shaft. Lift the shaft clear of the gearbox.

Support the engine at the rear of the oil sump by means of a small jack with a piece of wood about 6 in. square by 2 in. thick interposed between the jack and the sump.

Next remove the handbrake cable clip, the four bolts securing the rear engine support to the frame cruciform, and the clutch withdrawal pull-off spring. Release the clutch-operating chain by slackening off the adjustment at the bottom of the clutch pedal.

Remove the clutch bottom cover, which is secured by six screws.

Remove the two bolts which secure the self-starter and withdraw the starter from its housing.

Remove the four bolts which secure the clutch housing and gearbox to the crankcase.

Lower the engine on the jack until a dimension of 5 in. is obtained from the top edge of the toe-board to the clutch inspection cover lower screw (Fig. 10), when the complete gearbox and clutch-housing unit, together

with the rear support, can be drawn back to release the clutch shaft from the splines and then lifted downwards clear of the car.

When dismantling, drive layshaft out *from front to rear.*

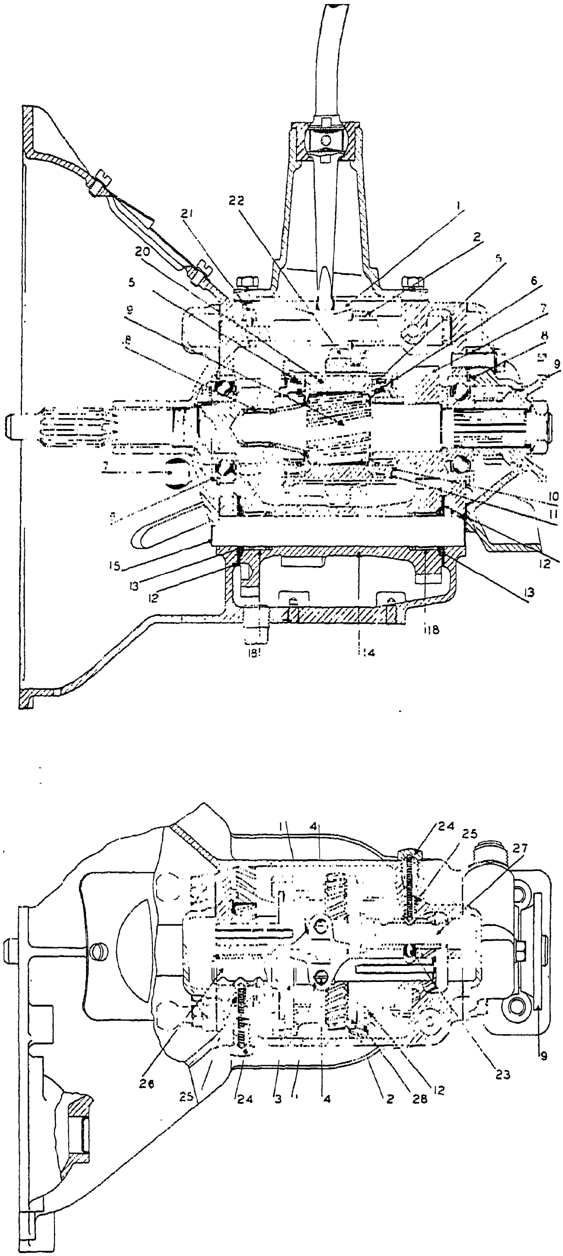


Fig. 11.—SECTIONED VIEWS OF GEARBOX (10-FOUR AND 12-

1. Selector jaws. 2. Striking fork (1st and reverse). 3. Striking fork (2nd and 3rd). 4. Striking fork retaining screw. 5. Synchro cone bronze inserts. 6. Synchro detent spring. 7. 2nd speed constant mesh gear. 8. Mainshaft ball race (rear). 9. Universal joint coupling flange. 10. Synchromesh cone. 11. Synchro cone retainer. 12. Layshaft thrust washers. 13. Steel retaining washer. 14. Layshaft cluster gear. 15. Layshaft. 16. Main drive pinion and ball race assembly. 17. Pivot ball. 18. Mainshaft front bearing needle rollers. 19. Mainshaft helical splines. 20. Mainshaft sliding sleeve. 21. Locating dowels. 22. 1st and reverse speed sliding gear. 23. Interlock ball. 24. Locking plunge spring retainer. 25. Spring loaded locking plunger. 26. Selector rail—second and top. 27. Selector rail—1st and reverse. 28. Reverse idler gear.

To Inspect Gearbox

Note the following points:

The maximum allowable end float of the layshaft cluster gear is ·017 in.

When new bushes are fitted to the reverse idler gear these should have a clearance on the shaft of ·002 in. to ·004 in.

No appreciable slackness should exist between rail and the bore of the selector fork. If the selector-ball springs appear to be weak, these must be renewed.

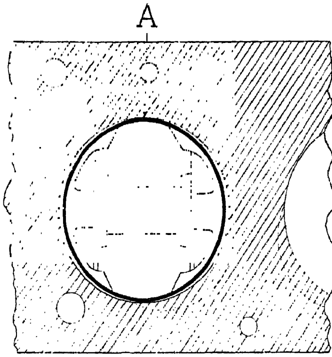


Fig. 12.—PLAN OF PISTON IN CYLINDER (25-H.P. MODEL G)

Bore, showing point of feeler insertion (A).

25-H.P. ENGINE (MODEL G)

The engine lubrication system is similar to that of the 10-h.p. engine described above.

The oil-strainer gauze which is fitted to the crankcase adjacent to the distributor must be removed and cleaned at regular intervals (the maximum period being every 2,000 miles, when the engine oil should be changed). To remove the gauze, unscrew the two setscrews holding the strainer cap to the crankcase, remove the cap, and withdraw the gauze element.

There is also an external oil filter, to which the same instructions apply as in the case of the 10-h.p.

Information given on the 10-h.p. relating to valve-rocker gear, valve clearances, grinding-in valves, gudgeon pins, connecting rods, valve timing, flywheel ring gear, applies also to the 25-h.p. engine. The valve guide on a 25-h.p. is $\frac{13}{16}$ in. above the cylinder head.

Pistons and Rings

For production purposes, the cylinder bores and piston dimensions are to the same limits as given for the 10-h.p. engine. In the case of the 25-h.p. engine, the standard grades of pistons available for service purposes are TB, TY, and TW, together with ·003-in., ·005-in., ·010-in., ·020-in., ·030-in., and ·040-in. oversizes, there being a machining tolerance of ·001 in. on all oversize pistons. Both standard and oversize pistons should be fitted so that they will just slide through the bores but will lock a ·0015-in. feeler of $\frac{1}{2}$-in. width placed at right angles to the gudgeon pins.

When making this check, the piston must be held so that it is at least 1 in. below the top face of the block and with the gudgeon pin in its normal relationship to the crankshaft (i.e. along the longitudinal axis of the crank-

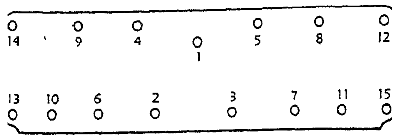


Fig. 13.—CYLINDER HEAD BOLT-TIGHTENING DIAGRAM (25-H.P. MODEL G)

Where reboring is necessary, it is imperative that oversize pistons are in the hands of the dealer and that the operator shall check the exact size of each piston individually before machining, by measuring the diameter of the pistons at the top of the skirt immediately below the ring lands and at right angles to the gudgeon pin.

These pistons are oval ground—to the extent of ·013 in.—and therefore a small displacement of the feeler from the central position will represent a considerable error in clearance (Fig. 12). Incorrectly placing the feeler strip merely 10° will cause an error of ·0005 in., whilst at 20° this increases to ·0012 in. Remember, also, to check in that portion of the bore over which the piston travels ; above or below this part will give a false reading.

Piston Rings

Inspection of the piston rings is not necessary, as *whenever they are removed from the piston new ones must be fitted.*

Before fitting the new rings to the pistons check them in the cylinder bore to ensure that the gap between the ends of the rings is *within the limits* ·008/·013 *in.* (·203/·330 *mm.*). This is very important.

Gudgeon Pins

See 10-h.p. model.

Connecting Rods

The out-of-parallelism must not be more than ·005 in. per inch, and no twist is allowable.

The radial clearance on the crank pins should be ·001/·0025 in.

When it becomes necessary to regrind the big-end journals of the crankshaft there are available connecting-rod assemblies with undersize big-end bearings. These are ·020 in. (·50 mm.) smaller than standard, and in order that the truing-up operation is carried out so that the correct clearance is obtained the pins should be machined to within the following limits :

Crank pin, finished diameter, 2·0425/2·0435 in.

Crankshaft

The four main-bearing caps can be removed by tapping *lightly* with a hammer while pulling the cap away from the block.

When it is necessary to regrind the crankshaft main-bearing journals

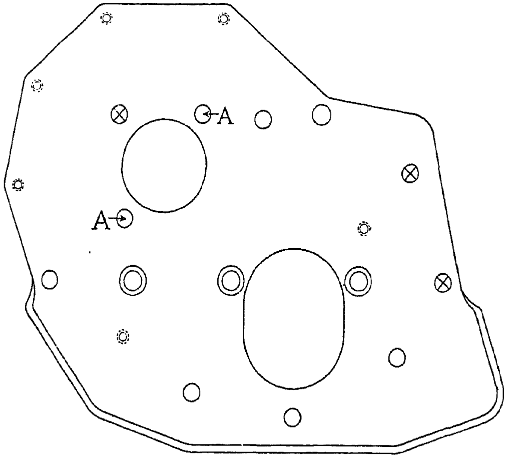


Fig. 14.—CRANKCASE FRONT PLATE (25-H.P. MODEL G)

and crank pins they should be finished to suit the ·020-in. undersize main bearings and connecting-rod big ends serviced by the Parts Department.

Scraping the journals is unnecessary if the shaft is ground to the finished dimensions as follows:

Crank pin	2·0425/2·0430 in.
No. 1 journal	2·058/2·059 in.
No. 2 journal	2·214/2·215 in.
No. 3 journal	2·245/2·246 in.
No. 4 journal	2·277/2·278 in.

Check the shaft for running out of truth by supporting between centres and taking indicator readings on Nos. 2 and 3 journals. The production limit for these readings is ·0015 in.

To Inspect Crankshaft Main Bearings

Check bearings for clearance, and if more than ·003 in. it is advisable to renew the bearings, as they are not adjustable.

Camshaft and Bearings

The end float should be from ·003 in. to ·006 in. The bearing clearances can be checked by inserting feeler strips, after dropping the sump, the standard clearances being ·0025/·004 in.

Crankcase Front Plate

When the plate is held up to the crankcase, the operator may be in some doubt into which holes the three ⅜-in. setscrews should be placed, in which case Fig. 14 will be found helpful, the correct holes being marked with an X.

Petrol System

The carburettor jet settings which have been found most suitable for conditions prevailing in the British Isles are:

ZENITH DOWNDRAUGHT CARBURETTOR

Main jet	130
Compensating jet	80
Slow-running jet	55
Pump jet	60
Progression jet	120
Choke-tube diameter	31 mm.
Needle seating	2·5 mm.

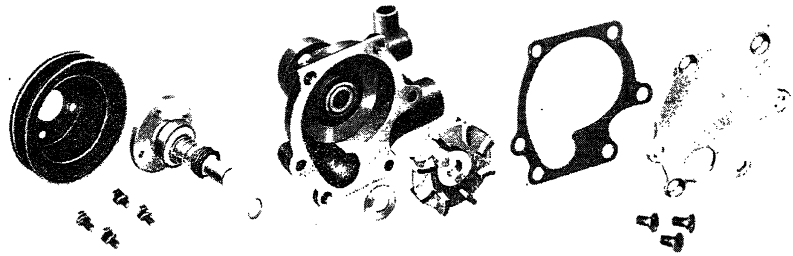


Fig. 15.—Exploded view of water pump (25-h.p. model g)
Left to right: fan pulley, pump shaft, showing front bearing, gland packing and circlip, water pump body, impellor, gasket and body cover plate.

To Remove Gearbox

As the gearbox must be withdrawn upwards the front seat and centre floorboard must be removed.

Provision must be made for supporting the rear of the engine, and therefore the outrigger bolts must be slackened off, the rear mounting bolts removed, and the rear of the engine raised very slightly.

Under no circumstances allow the weight of the engine to rest on the side supports.

Disconnect the speedometer drive and the wires from the reverse warning-lamp switch at the right-hand side of the gearbox. Detach the earth wire.

Disconnect the propeller-shaft flange coupling and remove the four bolts attaching the gearbox to the clutch housing.

The gearbox can now be withdrawn backwards and upwards, if necessary placing the gear lever in second or top gear to give more clearance.

To Dismantle

Remove the gearbox lid, lift off the shift bar and take away the selector-rail locking springs and balls.

Remove the setscrew which locks the first and second selector fork to the selector rail, slide this *forward* out of the box through the aperture provided, and lift out the striker fork.

Repeat this for the top and third selector rail and fork. Make certain that the reverse-gear selector is in the neutral position.

It is important that the layshaft cluster be lowered before the mainshaft assembly is removed. Tap out the layshaft *from front to rear.*

Note.—Never attempt to drive the shaft out in the reverse direction, which would damage the countershaft bushes owing to the slightly increased diameter at the rear of the shaft.

This allows the layshaft gears to lie in the bottom of the gearbox.

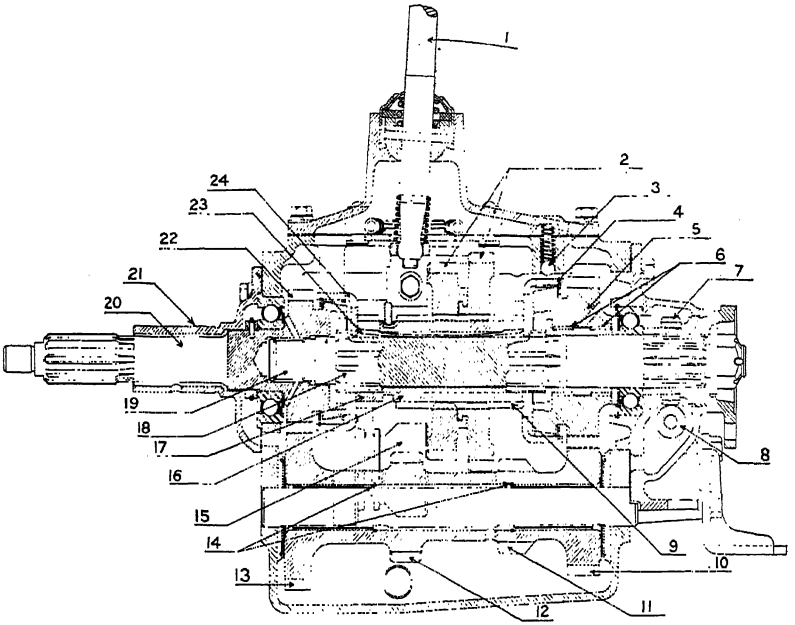


Fig. 16.—SECTIONAL VIEW OF GEARBOX (25-H.P. MODEL G)

1. Change speed lever. 2. First and second sliding gears. 3. Selector rail locking ball. 4. Third-speed synchronising drum. 5. Third-speed mainshaft gear. 6. Needle-roller bearings. 7. Speedometer driving gear. 8. Speedometer driven gear. 9. Third-speed engagement dogs. 10. Third-speed layshaft gear. 11. First-speed layshaft gear. 12. Second-speed layshaft gear. 13. Layshaft constant-mesh gear. 14. Circlips retaining layshaft bushes. 15. Reverse sliding gear. 16. Top- and third-speed sliding sleeve. 17. Top-speed engagement dog. 18. Mainshaft. 19. Mainshaft spigot. 20. Clutch shaft. 21. Clutch release bearing sleeve. 22. First reduction pinion. 23. Detent spring. 24. Top-speed synchronising drum.

Carefully draw out the mainshaft and sliding sleeve, leaving the first and second sliding gears in the box. Take care to retrieve the needle-roller bearings from the mainshaft spigot end. Lift out the first and second sliding gears.

To remove the main drive gear detach the front cover.

The main drive shaft must be gripped between clamps in a vice whilst the locking-spring wire and nut are removed. (Note that this nut has a *left-hand* thread.)

Tap the gear backwards into the box and remove and then tap forwards the ball bearing. Lift out the layshaft gears with the two thrust washers.

Before commencing on the reverse-shaft sliding assembly, remove the reverse-light switch (and plunger).

Tilt the gearbox until the interlocking plunger can be removed.

The reverse selector rail and striking fork can now be taken away in a manner similar to that of the others.

The hexagon-headed locking pin must be removed and the reverse idler shaft driven out of the box rearwards, bringing with it the expansion plug.

To dismantle main-shaft assembly, draw off the sliding sleeve together with the three detent springs.

Grip the shaft between suitable clamps in a vice, remove the cotter pin, nut, and washer, and draw off the universal-joint flange coupling. The speedometer driving gear seldom needs to be disturbed.

Remove rear cover and bearing.

To enable the third-speed gear to be removed from the shaft the synchronising drum must be released.

The gear can now be drawn off the shaft.

If it is required to examine the synchromesh drum this can be removed by springing off the snap-ring.

The first and second sliding gears are merely bayoneted together, but unless either of them is damaged to an extent which necessitates renewal, they need not be disturbed.

To remove the gear lever, press down the bayonet cap and turn to the left, some effort being required to accomplish this due to the resistance of the spring.

To Inspect

Check the splines of the sliding sleeve and the first and second gears. There should be a minimum of backlash at these points. Excessive backlash has a distinct bearing on the question of jumping out of gear.

In checking the thrust washers of the layshaft gear bear in mind that the maximum end float of the latter must not exceed ·028 in.

Bushes.—The clearance between the layshaft-gear bushes and shaft is ·004 in. to ·006 in. In the case of clearances higher than the maximum, it is advisable to fit new bushes and/or a new layshaft as necessary. As the bushes are prevented from moving inwards to the centre of the shaft by two circlips, the bushes will have to be turned out in a lathe. On fitting new bushes the following important points must be noted.

The bushes are not identical, in so far as the front bush has a right-hand spiral oil groove and the rear bush a left-hand spiral groove. Press in the bushes until their inner ends butt against the circlip.

The bushes must now be cleaned up to provide the necessary clearance. In this respect it must be noted that a reamer will not serve the purpose. To attain a suitable finish the gear must be carefully set up in a lathe so that the run out of the outer diameter of the teeth does not exceed ·003 in.

The bushes fitted in the reverse idler-gear shaft are pressed out in the usual manner. New bushes must have a clearance of ·004 in. to ·006 in.

There should be no appreciable slackness between the rail and the

bore of the selector fork. Selector-ball springs which appear to be weak must be renewed.

To Reassemble

When reassembling, it is most important to replace the correct number of needle rollers, as serious damage will follow if one or more needles are left out. The gear will tend to " skew " and will eventually seize. Take great care in assembling the gear over the needle rollers, and in particular to those of the first row as, if the gear is not very carefully centred, they may be pushed slightly forward and so ride over the centre portion of the sleeve. Very little further pressure under such circumstances will certainly break the needles. A tight rubber band can be used to fix the needles in position until the bore of the gear is entered sufficiently.

Test the end float of the third-speed gear, this being ·003 in. to ·007 in. The gear should revolve freely.

To Replace

Place a new gasket in position, preferably sticking it to the gearbox with the aid of grease.

Move the gear lever to engage the top-speed gears. It is presumed that the engine still remains jacked up to the extent of having $\frac{1}{8}$-in. clearance at the side bearers.

If the clutch pedal has not been disturbed the clutch friction plate will be in a correct position for assembly of the gearbox. It is advisable, however, to ensure this by passing a spare mainshaft gear through the clutch withdrawal collar, friction plate, and into the spigot. Withdraw and lower the gearbox into place.

VAUXHALL LIGHT 6, 12, AND 14-H.P. MODELS " D "

Oil-pump Data

Oil-pump driving spindle—end float	·004/·002 in.
Clearance in body	·002/·001 in.
Oil-pump idler gear—clearance on spindle	·002/·001 in.
End float in casing	·006/·0035 in.
Oil-pump relief valve—plunger clearance	·0024/·0007 in.

To Replace Cylinder Head

The process of refitting the head will be assisted and the correct position of the gasket maintained if two location studs are made up. Old cylinder-head bolts will be found suitable for this purpose if the heads are cut off. Screw these into the block, one at either end, two or three threads only for ease of removal after some of the bolts have been replaced. Use a new gasket, smearing a little grease on both sides before

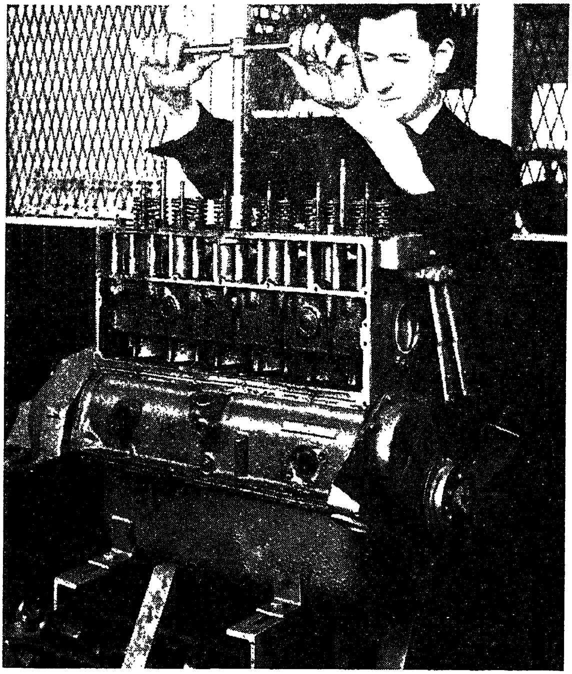


Fig. 17.—DECARBONISING: VALVE-GRINDING OPERATIONS. ENGINE OUT OF CHASSIS

Operation showing removal of cylinder-head bolts prior to dismantling engine completely. (*By courtesy of Shaw & Kilburn.*)

placing it in position over the studs.

To Renew Valve Guides

Remove valve from the guide or guides which are to be renewed.

The old guide may be driven out from the cylinder head with a suitable drift without difficulty, as the guides are only a moderately tight fit in the cylinder head.

Up to engine Nos. DY.713521 and DX.456751 inclusive, the guide locates a cup-shaped washer on the cylinder head, and this washer will fall adrift when the guide is removed. Its purpose is to locate the lower end of the valve spring.

When fitting the new guide, the cup washer should be passed over the small diameter of the guide, so that when the latter is pressed into the cylinder head the concave side of the washer is face downwards on the top surface of the head.

The most satisfactory method of inserting the guide is to press it into position ; it should be inserted until the larger diameter of the guide just holds the cup washer firmly without movement on the top face of the head. Do not continue the pressure after this stage, otherwise the cup washer will be distorted.

From engine Nos. DY.713522 and DX.456752 onwards, the cup washer which locates the lower end of the valve spring is deleted and a felt oil seal fitted over the top of each guide, which is retained in position by a brass pressing which also acts as a guide for the valve spring.

Valve Clearances

The correct clearance between the rockers and the top of the valve stem is ·008 in. with the engine hot.

The usual method of setting the clearance on each valve in turn with the engine stationary is not recommended. Greater accuracy is obtained by adopting the following procedure :

Run the engine until it is thoroughly warmed up. Run the engine as slowly as possible. Remove the valve-rocker cover.

Whilst the engine is running slowly, try to insert a ·008-in. feeler gauge. If this is not possible, or the feeler slides in easily, slacken the adjusting screw locknut and turn the adjusting screw by means of a screwdriver until the ·008-in. feeler gauge is nipped between the end of the valve and the tip of the rocker arm. The screw should then be slackened slightly until the gauge can just be withdrawn. Finally, tighten the locknut.

As a check on the setting, try to insert a ·010-in. feeler gauge. If this is possible without force, the clearance is too great and the previous operation must be repeated.

Inspect for slackness between the rockers and the shaft. The clearance should not be excessive (·002 in. when new) and, if necessary, the rockers should be rebushed. It should be noted that the holes by means of which oil escapes through the top of the rockers are not drilled in new bushes, and it will be necessary to drill these when the bushes have been pressed into position in the rockers.

Examine for wear on the rocker tips and stone down as necessary.

To Inspect Water Pump

Renew the shaft if it shows appreciable signs of scoring due to the gland packing or to wear on the bearing surfaces, as otherwise it will be impossible to maintain a watertight gland. The shaft is supplied as an assembly with the impeller.

*Up to Engine Nos. DY.*711873 *and DX.*829916. Up to these engine numbers the front bush was of a special porous material.—In view of the special nature of the front bush it is most important that renewals be effected with genuine parts.

From engine Nos. DY.711874 and DX.829917 onwards a ball bearing of the shielded type is used to support the front end of the spindle, instead of a bush. Lubrication will be necessary only at very long intervals, as wear is infinitesimal.

Examine front bush or bearing and rear bush for wear, and replace as necessary.

The condition of the gland packing will suggest whether replacement is necessary.

To Reassemble

Note the following important points :

Before inserting the shaft fill the grease-cup with suitable grease and

give several turns to make sure that grease is passing through to the gland packings and is issuing from both holes in the distance-piece.

Insert the rotor and shaft and fibre thrust washer. Press on the pulley to give ·003-in. end float of the shaft. This clearance is highly important.

The adjusting gland nut should be tightened until it just bites on the packings. Re-inspect for water leaks after the engine has been run.

It is very important when tightening the gland nut to do so just sufficiently to prevent water leaks. Over-tightening will cause seizure of the shaft.

It is also most important that a special waterproof grease is used in the greaser, as other types will be readily dispersed into the cooling system and result in poor lubrication of the pump and eventual choking of the radiator.

Connecting Rods and Pistons

The connecting-rod and piston assemblies should be withdrawn past the crankshaft, taking care not to damage the pistons against the crank webs.

Two types of pistons have been used in production, the later type being the oval ground, which superseded the relief-ground type at chassis Nos. DX.655401 and DY.514001. The difference between these two types of piston is plainly visible in so far as in the early type the relief at the sides of the piston is quite marked, whilst the oval ground have perfectly plain-surfaced walls.

The data below gives full information as to the oversize pistons serviced, and it is more satisfactory in all cases to determine and obtain the size of the pistons needed and then to hone to give these pistons the requisite clearance, rather than to hone to specified dimensions first.

PISTONS

Type of piston	Aluminium alloy—flat crown—split skirt.
Piston diameter (over working surfaces) .	Four standard sizes are used in production :

12 H.P.		14 H.P.	
(1) 2·2415/2·2420 in.	Stamped W. on crown.	(1) 2·4185/2·4190 in.	Stamped W. on crown.
(2) 2·2410/2·2415 in.	Stamped Y. on crown.	(2) 2·4180/2·4185 in.	Stamped Y. on crown.
(3) 2·2405/2·2410 in.	Stamped B. on crown.	(3) 2·4175/2·4180 in.	Stamped B. on crown.
(4) 2·2400/2·2405 in.	Stamped R. on crown.	(4) 2·4170/2·4175 in.	Stamped R. on crown.

All standard pistons supplied as spares are either the W or Y sizes as listed above.

The following oversize pistons are also supplied :

·003 in., ·005 in., ·010 in., ·020 in., ·030 in., and ·040 in., each complete with fitted gudgeon pins.

The oversizes are manufactured to a tolerance of ·001 in.—the top machining limit being greater than the maximum dimension of the Y standard pistons by the amount of oversize. For example, the diameter of the ·020-in. oversize piston would be 2·2615/2·2605 in. or 2·4385/2·4375 in. for 12-h.p. and 14-h.p. engines respectively.

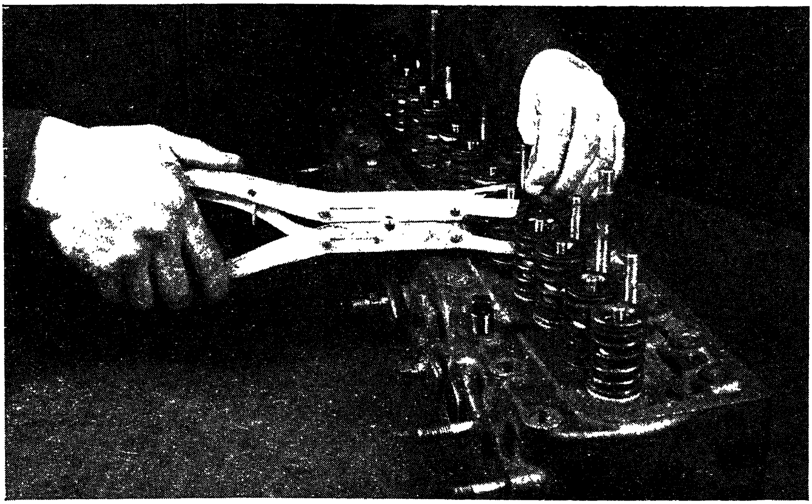


Fig. 18.—REMOVING VALVE COTTER (USING SPECIAL VALVE-SPRING COMPRESSION)
(*Ey courtesy of Shaw & Kilburn*)

Piston clearance—	
Oval-ground type	Light pull ·0015-in. feeler strip ½ in. wide inserted at right angles to gudgeon pin on the full-skirt side of piston.

The pistons are correctly fitted when a feeler strip of the thickness indicated can be drawn between the full-skirt side of the piston and the cylinder bore.

Piston Rings

The clearance of the rings in the piston grooves should be ·0005/·002 in. (compression and scraper rings). When placed in the cylinder bore the gap between the ends of the piston rings should be between the limits of ·004 in. to ·008 in.

Gudgeon Pins and Bearings

If honing and fitting of oversize pistons has been resorted to, the question of the gudgeon-pin fit in the piston itself will not arise, owing to the fact that replacement pistons are supplied complete with properly fitted gudgeon pins. However, the fit of the new gudgeon pins in the old small-end bushes should be checked, and, if slackness is apparent, the bushes should be renewed.

The gudgeon pin should be a tight push-fit in the piston, but should not fall out of the small-end bush by its own weight. If this condition is not fulfilled, ·003-in. oversize gudgeon pins are available, which may enable the operator to produce a satisfactory fit.

New small-end bushes carry a reaming allowance in the bore, and great care must be exercised in reaming to produce as fine a finish as possible.

Connecting Rods

Clearance on the crankshaft journals should be between the limits ·0005/·002 in., and the end float ·004/·011 in. No shims are fitted between the cap and rod, and in order to take up appreciable slackness it is, therefore, desirable either to remetal the existing rods or fit new rods. A small amount of slackness can, however, be taken up by rubbing down the mating surfaces of cap and rod with fine emery cloth on the surface plate, taking great care to rub down evenly and squarely.

It is recommended as a check of correct radial clearance that the rod be bolted to its crankshaft journal, and the small end allowed to drop over, which it should do by virtue of its own weight, but there should be no slackness. If the crankshaft journals are worn and have developed ovality, this check cannot, of course, be used.

The maximum allowable out-of-parallel is ·0005 in. per inch. No twist is allowable between the big and small ends.

When reassembling the pistons to the rods it is very important to make sure that the split-skirt side of the piston is on the same side as the numerals previously marked on the big-end bosses.

To Adjust Crankshaft Main Bearings

Adjust Nos. 2 and 3 bearing caps first.

It is normal practice to leave each half of the bearing liner standing slightly proud of the cap. This amounts to ·002 in. to ·0025 in. if measured all on one side.

The liners and caps should be rubbed down gently on emery cloth as an assembly, great care being taken to maintain a flat surface, and the liners then removed and the caps given two or three additional strokes before being thoroughly cleaned and rebolted to the crankcase to check the diametral clearance. This procedure should be repeated until the correct clearance of ·001 in. to ·003 in. is obtained, about which the operator can satisfy himself by the use of a piece of feeler strip placed along the centre of the bearing liner before it is bolted into position.

To check the clearance the operator should cut out small pieces of feeler strip of ·001-, ·002-, and ·003-in. thickness. The size of these pieces is usually $\frac{3}{8}$ in. by $\frac{1}{2}$ in. Bearings are tested separately, and when satisfied that the shaft is not gripped on tightening down the cap, this should be removed and the ·001-in. or ·002-in. feeler strip inserted. If the shaft is held by either of these feeler strips, the clearance is within the limits. If a test is made with the ·003-in. feeler strip and the shaft can be turned, then the liner and cap should be rubbed down slightly according to previous instructions.

The crankshaft end float is controlled by No. 2 bearing and should, therefore, be checked when attending to this bearing, the correct float being from ·003 in. to ·008 in.

Excessive crankshaft and float can be overcome only by fitting a new No. 2 bearing complete.

Repeat this work for Nos. 1 and 4 bearing caps.

Shims are not provided between the main bearing caps and the crankcase, so that adjustment of these bearings by facing down the caps must be limited to ·006 in. If further adjustment is made in this manner it will result in the eventual necessity for the renewal of both caps and bearings. Greater clearance should be taken up by fitting new bearings, which is fully described below.

Oil bearings thoroughly with engine oil before replacing. Fit new bearing-cap bolt lock washers in all cases and tighten cap bolts evenly.

It is important when refitting the cap bolts on Nos. 1 and 4 bearings to dip the bolt threads in "Osotite" or a similar jointing medium to prevent oil leaks, as it will be noticed that these two bearings are outside the sump.

When all the bearings have been correctly taken up it should be possible to rotate the shaft by gripping the flywheel rim with the hands.

To facilitate repair work after regrinding the crankshaft main journals, ·020-in. undersize main bearings are available.

Flywheel

The maximum allowable run-out of the flywheel is ·004 in. both on the outside diameter of the rim and on the rear face.

To Fit New Flywheel Ring Gear

The ring gear should be placed in a furnace, or other means resorted to, to raise its temperature evenly to 380–390° C., equivalent to a dark blue coloration of the steel. *The temperature should be maintained, but not exceeded in any circumstances,* for twenty minutes.

Any scale which has been formed on the surfaces which make contact with the flywheel, i.e. on the back face (unchamfered side of the teeth) and on the inner circumference of the ring gear, must be removed and the ring gear rapidly dropped into position over the front of the flywheel rim. The chamfered edges of the ring-gear teeth face the front, or engine side, of the flywheel. The gear when in position must be allowed to cool freely in air.

Carburettor

Model—Zenith Downdraught 30 V.M.

Standard settings which have been found most suitable for conditions prevailing in the British Isles are :

	DY.	*DY.*	*DX.*
	To engine No. 711762	*From engine No.* 711763	
Choke	22	21	22
Main jet	90	85	95
Compensating jet	80	90	70
Slow-running jet	55	50	55
Progression jet	75	75	75
Compensating jet, air-bleed	1·8 mm.	2 mm.	1·8 mm.
Needle seating	1·75 mm	1·75 mm.	1·75 mm
Float-level	17 mm. below top of bowl.		

To Remove Gearbox

As the engine is mounted at the rear through the medium of the gearbox, it is necessary to support the engine before the gearbox is removed.

The best method of doing this is to place a jack under the rear of the sump, with a suitable block of wood interposed. The jack should be raised just sufficiently to take the weight of the engine.

Remove the gearbox rubber cover, the front section of the propeller-shaft tunnel, and the front section of the right-hand floorboard. Remove the metal cover linking both toe-boards, the dipper switch, and the right-hand section of the toe-board.

Disconnect the propeller shaft from the front flange and lower until it rests on the centre section of the chassis frame.

To remove the gearbox, remove the four setscrews, one on each side and two underneath the gearbox, by which it is attached to the cradle.

Remove the four bolts, two each side, which hold the gearbox support brackets to the cradle.

Drain oil from gearbox.

Disconnect the speedometer cable and remove the four setscrews attaching the gearbox to the clutch housing.

The gearbox should then be drawn rearwards without lowering it until the front end of the main drive gear is clear of the clutch housing.

Note.—Unless the clutch is to be removed also, do not release the clutch by pressing on the pedal whilst the gearbox is out of the vehicle, as this will necessitate recentring the clutch disc.

Three types of gearbox have been fitted, and while the changes are minor, they affect interchangeability of a number of parts.

In the first type, selection of the third- and top-speed gears was controlled by an upstanding fork jaw, the top end of which engaged the gear lever at a point a little below its fulcrum.

In the second type, the upstanding fork jaw was eliminated and the lower end of the gear lever engaged the third- and fourth-speed selector direct.

In the third type, various improvements were incorporated, and the

old-type upstanding fork jaw and gear lever were reintroduced in similar but not identical form.

The engine numbers at which the second and third types were introduced are as follows :

Second type	DY.712480.
	DX.448254.
Third type	DY.714408.
	DX.468078.

To Dismantle

To remove the striking forks from the box it is necessary first to remove the rear-bearing housing setscrews, swing the housing aside, and drive out the layshaft from front to rear, leaving the layshaft gears at the bottom of the box.

It will be noted that the left-hand screwed nut which locks the bearing to the main drive gear incorporates an oil-throwing thread. To remove the nut, grip the main shaft in a vice, using a pair of clamps to prevent damage.

Before dismantling the main shaft the relationship between the sleeve and the shaft should be marked by means of paint or other suitable marking.

To Reassemble

Before fitting the third-speed constant-mesh gear, the double row of needle-roller bearings must be placed in position on the steel sleeve, which has previously been pressed right home on the rear end of the shaft, flange end first. The needles can be held in place by a small quantity of grease.

Note.—In all needle-bearing assemblies it is absolutely essential that the correct quantity of needle rollers be used ; in this case the number required is 156. Failing to replace the correct number will result in difficulties due to " skewing " and consequent seizure.

Place the gear carefully over the rollers, taking great care not to dislodge any of the latter.

When the gear is finally located on the assembly it must be perfectly free to revolve and should have an end float of ·003/·007 in.

Incorporated on the boss of the universal-joint flange is a screw-type oil-return device. Freely coat this screw with marking paste and carefully place on the shaft in the housing. Rotate, and on withdrawing the flange any fouling will be shown up by the marking paste, and can be dealt with accordingly. This operation is left until the rear housing has been fitted to the box.

After fitting the third-speed gear, the rear bearing and housing, and the flange to the main shaft, the sliding sleeve and detent springs can be slipped over the front end of the shaft.

When correctly in position, the thickened-up step on either end of

each detent spring will protude and be visible for an equal distance at each cut-away portion of the sliding sleeve.

It is essential to see that the first- and second-speed sliding gears are bayoneted together to the fullest possible extent, failing which the bayonet lugs may be subject to damage.

Insert the striking fork in its groove between the first- and second-speed sliding gears and place the assembly inside the box, entering the sleeve portion of the fork into the place provided at the centre rear of the box, and slide the assembly backwards.

Enter the main-shaft assembly through the rear aperture, engaging the sliding gears on the sliding sleeve as it is moved forward. As soon as the striking-fork slot on the sliding sleeve becomes visible, place the selector in position, and, continuing the forward movement of the assembly, enter the striking-fork sleeve in its aperture at the front left side of the box, and enter the main-shaft spigot.

Enter the first- and second-speed selector rail from the rear of the box. Place a $\frac{5}{64}$-in.-diameter split-pin in the hole provided on the underside of the striking fork, and place the fork in the box with the locking pin locating hole towards the front.

The 14 h.p. "J" model and the changes which have occurred in later 10-Four and 12-Four models form the subjects of a later article.

REPAIR NOTES ON ROVER CARS

THE ENGINE, CLUTCH, AND GEARBOX

By F. G. HAWKINS.

THE notes in this article relate to the following models: 10-h.p., 1934–9; 12-h.p., 1934-9; 14-h.p., 1934–9; 16-h.p., 1937–9; and 20-h.p., 1937–9.

All Rover engines on the models mentioned above are of the overhead-valve type. The valve gear is totally enclosed and lubricated under pressure. Operation is by push rods from a camshaft in the crankcase.

A gear-type *oil pump* supplies lubricant to all bearings via a *filter* located in the base chamber, which can be withdrawn for cleaning after unscrewing a plug on the side of the sump.

Cooling is carried out by a water pump assisted by a fan, and on all models except 1934 it is controlled by a thermostat.

Ignition is by battery and coil (12-volt) and is controlled manually for part of its range and by centrifugal mechanism in the distributor for the remainder on all models prior to 1937. In 1937 this gave way to full automatic control on 16- and 20-h.p. models, and the four-cylinder models followed the same trend in 1939.

Engine mounting is of the type known as "floating power," and is designed to enable adjustments to be made for increasing or decreasing engine movement.

Clutch is of the single-plate pattern and requires no lubrication other than that supplied via the hollow primary shaft to the clutch-

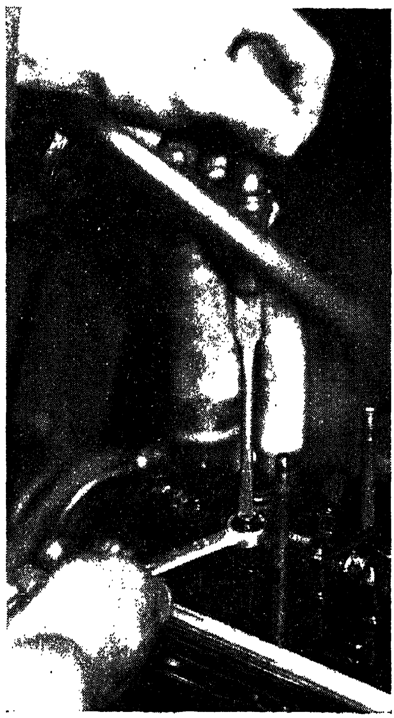


Fig. 1.—Tappet adjustment

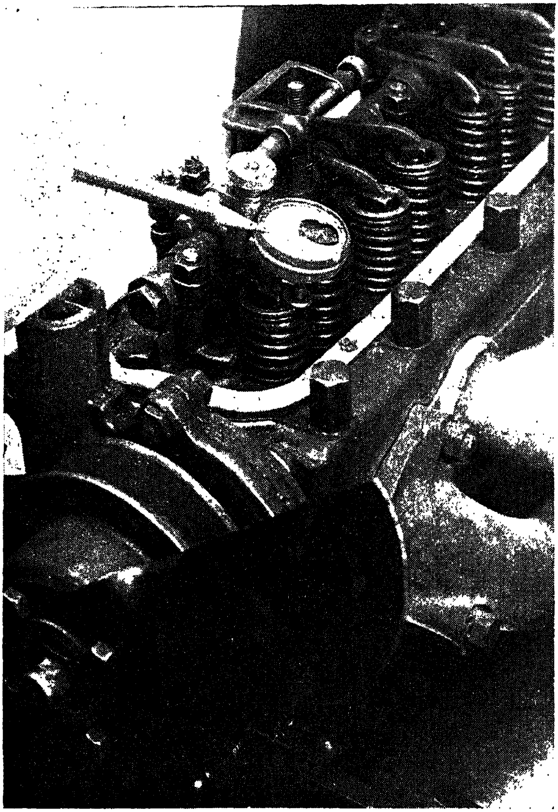


Fig. 2.—WHEN FINDING E.P. (EXHAUST PEAK) A DIAL GAUGE IS ESSENTIAL (ALL MODELS 1934–9)

thrust bearing. Operation is by Bowden cable on all models with the exception of 1936 and 1939; by "direct-pull" cable in conjunction with a compression rod on 1936 models, and by direct cable and rod on 1939 models. This form of operation is necessary to allow for engine movement.

DECARBONISING

14-h.p. Models

The amount of necessary dismantling that has to be carried out in order to decarbonise any of the engines under review is very small, and the order in which parts are removed is apparent upon examination. There are, however, several points peculiar to Rover engines that require emphasis, and they are detailed in the following text.

Tappet Adjustment

The correct tappet clearance is ·005-in. on engines prior to 1937, and ·010-in. on engines after 1937, with the engine hot on both inlet and exhaust valves. By "hot" we mean the general working temperature of the engine, and nothing less will do. Both this point and an exact clearance of ·005-in. (or ·010-in.) are very important if the best results are to be obtained, and ·005-in. (or ·010-in.) clearance can be obtained *only* with the aid of a ·006-in. and a ·004-in. (or ·011-in. and a ·009-in.) feeler gauge used in such a manner that the latter is an easy fit and the former will not enter. It is also very important that tappets should all be on the

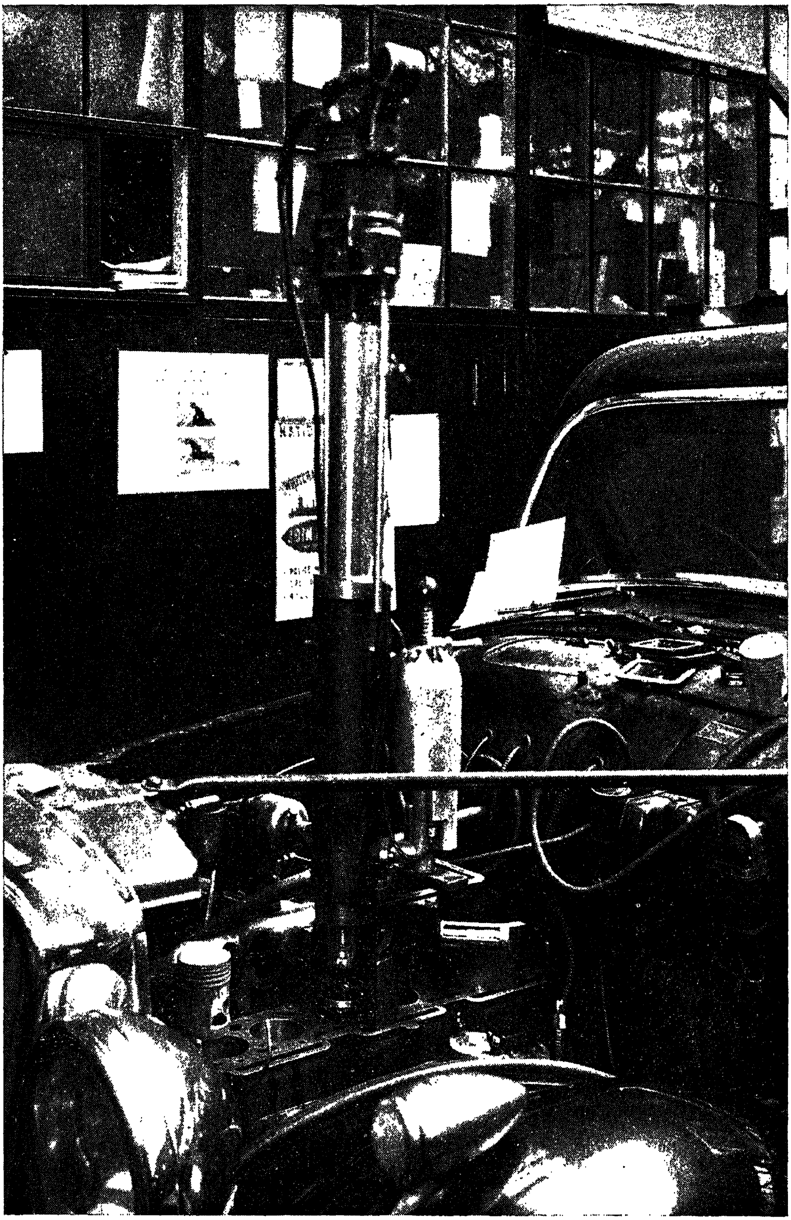


Fig. 3.—SHOWING THE SMALL AMOUNT OF DISMANTLING REQUIRED FOR A REBORE

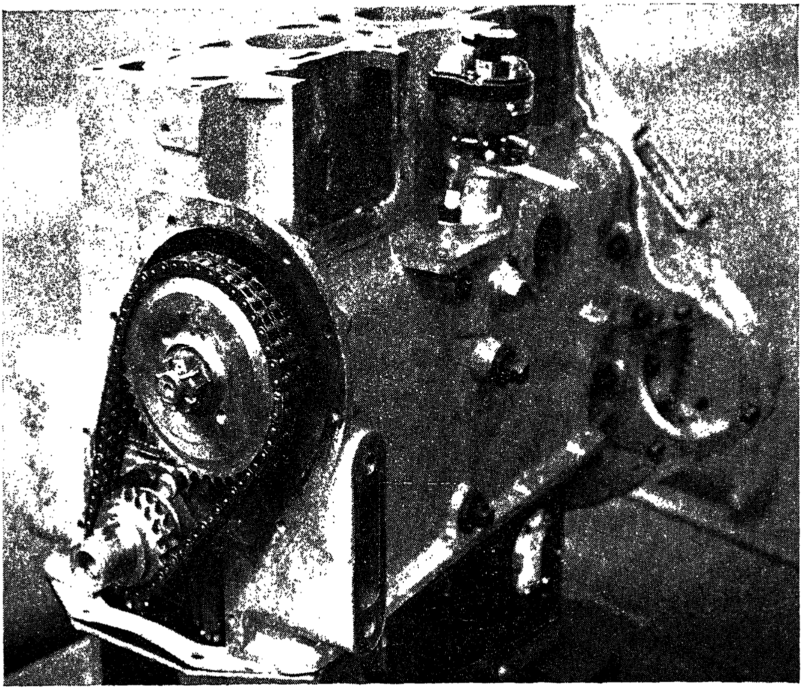


Fig. 4.—CAMSHAFT TIMING—ALL 4-CYLINDER MODELS 1934–9, ALL 16- AND 20-H.P. MODELS AND 1939 14-H.P. MODELS

If, after chain wheel has been set correctly, the chain will not fit, an alternative keyway is provided. Refit wheel and try again.

back of their respective cams whilst the clearance is being checked ; you will be sure of this if each tappet is brought to the peak of its lift and then the engine is turned through 360°.

On all engines as turned out from the works the correct clearance is given on a plate fixed to the rocker cover—a black plate for ·005-in. and a red plate for ·010-in.

Flywheel Marks

All flywheels should be marked as follows :

F.A.4 (four-cylinder engines) or F.A.6 (six-cylinder engines). These letters indicate the *firing point,* and when they are brought opposite the pointer in the timing aperture on the clutch housing, the distributor should be just beginning to separate, with the manual ignition control in the advanced position. In some instances the letters S.F.Adv. are used instead of F.A. The letters E.P. are used to indicate the point where No. 1 *exhaust valve* should reach the peak of its lift or be fully open.

The letters "T.D.C." indicate the point where Nos. 1 and 4 (or 6) pistons are at the top of their stroke.

In instances where no markings are to be found, or someone has replaced the flywheel on the wrong studs, the following points should be remembered :

The F.A. mark is 11° from T.D.C. on four-cylinder models ; 16° on 14-h.p. models ; 8° on 16-h.p. models ; and 12° on 20-h.p. models.

The E.P. mark is 108° from T.D.C. on all models. It is also useful to note that one tooth on the flywheel equals 3½°.

Retiming Engines

It will have been noticed in the previous paragraph, "Flywheel Marks," that the position "exhaust peak" is used when timing Rover engines instead of the more orthodox method.

An unusual cam form makes this method necessary, as a very gentle ramp is used at the point where the inlet valve opens, making it next to impossible to determine with reasonable accuracy exactly the point where the inlet valve does commence opening. These remarks are true of both four- and six-cylinder models.

Proceed as follows on all 14-h.p. models except 1939 :

Assemble the chain and chain wheels in any position, but use only one setpin to retain wheel to camshaft, and then adjust the chain to a normal running tension by slackening the dynamo bolts and moving it away from the engine.

Turn the engine again until the E.P. mark on the flywheel is in line with the pointer in the timing aperture on the side of the clutch housing.

Check the holes in the camshaft and determine if three of them correspond with

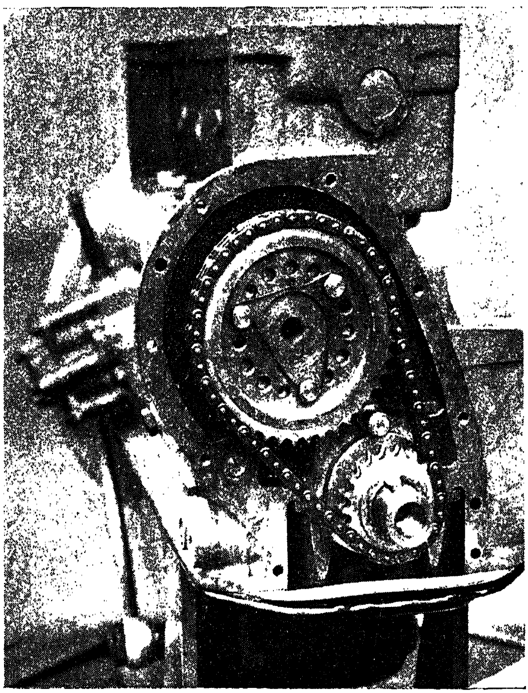


Fig. 5.—"LOOSE HUB" TYPE OF CAMSHAFT TIMING AS USED ON ALL 1934–8 14-H.P. MODELS

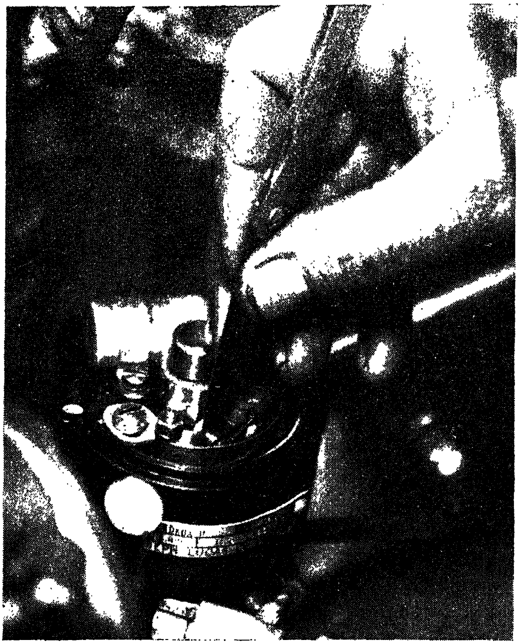


Fig. 6.—SETTING CONTACT POINT GAP

This operation cannot be carried out too carefully. Remember that an error of ·001 in. at distributor gap is equal in effect to 1 degree early or late in engine timing.

three holes in the camshaft; if they do not, remove the wheel and turn it one tooth in either direction, taking care that nothing else moves. In one of these two positions, the set-pins will register.

Fit all the pins and check the timing a second time; if it is correct, fit *new* locking wire through the holes provided in the bolt heads.

All four-cylinder Models, all 16- and 20-h.p. Models, and all 1939 14-h.p. Models

To retime, rotate camshaft in running direction, i.e. clockwise when viewed from the front, until No. 1 exhaust valve is at the peak of its lift.

Turn the engine until the E.P. mark on the flywheel is in line with the pointer in the timing aperture on the clutch housing, and then fit the chain.

The camshaft chain wheel is fitted with two keyways and it may be necessary, should the first position be incorrect, to utilise the second.

Special Note

To determine the exact point at which the exhaust valve reaches the peak of its lift, considerable care is needed. If a dial indicator is available, it will provide a simple and accurate method of determining this point. It should be mounted on an adjacent rocker-shaft stud with the aid of a small angle bracket, and its use will speed up matters considerably.

Retiming the Ignition

Turn the engine over until the F.A. mark on the flywheel corresponds with the pointer in the timing aperture with *both valves on No.* 1 *cylinder closed.*

The rotor arm and No. 1 H.T.-lead terminal on the distributor head should now correspond. If the rotor is approximately 180° away from No. 1 cylinder position, remove the oil pump and rotate the driving shaft in the required direction until the correct position is obtained. Set the manual ignition lever on the steering column to the fully advanced position, or, on all 16- and 20-h.p. and 1939 14-h.p. models set the octane selector at " 0 " on the sliding scale.

Set the distributor points just breaking by slackening the pinch bolt on the split lever under the distributor and rotating the head bodily the required amount. The firing order is 1, 5, 3, 6, 2, 4 on six-cylinder models and 1, 2, 4, 3 on four-cylinder models.

Replacing Rocker Shafts

When replacing rocker shafts after decarbonising, remember that excessive oil consumption can result if they are incorrectly fitted.

In each rocker bush there are two oil holes, and in the rocker shaft there is one oil hole for each rocker.

Assemble the shaft so that the oil hole in the shaft is as far away from the two holes in the rocker as possible. You will be sure of this if the holes in the shaft are pointing towards 5 o'clock when viewed from the front of the engine on all 14-h.p. prior to 1939, and towards 7 o'clock on all 10/12-h.p. engines and all 1937–8 16- and 20-h.p. engines.

On all 1939 six-cylinder engines the rocker shaft is positively located.

TIMING CHAIN ADJUSTMENT

14-h.p. Models 1934–5–6–7

On all these models the dynamo is driven by the timing chain, and adjustment is carried out by slackening the dynamo-retaining bolts and moving the dynamo outwards from the cylinder block. In order to prevent the possibility of the chain slipping a tooth and so making retiming necessary, a wedge should be inserted between the dynamo and engine and tension exerted outwards before loosening the bolts.

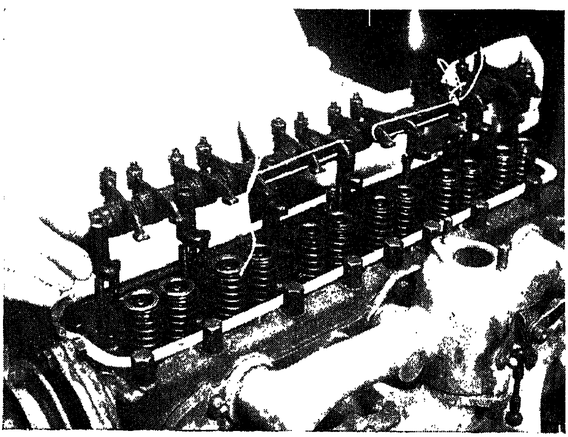


Fig. 7.—ON ALL 6-CYLINDER MODELS PRIOR TO 1938 TIE HALVES OF ROCKER ASSEMBLY TOGETHER BEFORE REMOVAL

All Four-cylinder Models, all 16- and 20-h.p. Models, and 14-h.p. Models 1938–9

The timing chain is not adjustable on these models.

CLUTCH REPAIRS

The clutch used on both four- and six-cylinder engines is of the Roper and Wreak pattern, from 1934 to 1936 (*see* appropriate section), and so far as 1936 models and a few late 1935 models are concerned, they are fitted with "shock-absorber" hubs to the floating plate and an oil-deflector plate. The addition of these two points makes no difference to service instructions, but it is interesting to note that they can be added to previous models without complication or alteration in any way. From 1937 onwards a Rover-pattern clutch assembly is used, and its principal difference lies in the fact that twelve springs are used instead of nine as formerly, and the clutch thrust race is self-aligning. A study of the two illustrations will serve to show the difference.

Clutch Controls

Owing to the use of a flexible engine mounting, it is necessary for the clutch pedal to be mounted in such a manner that it is independent of engine movement.

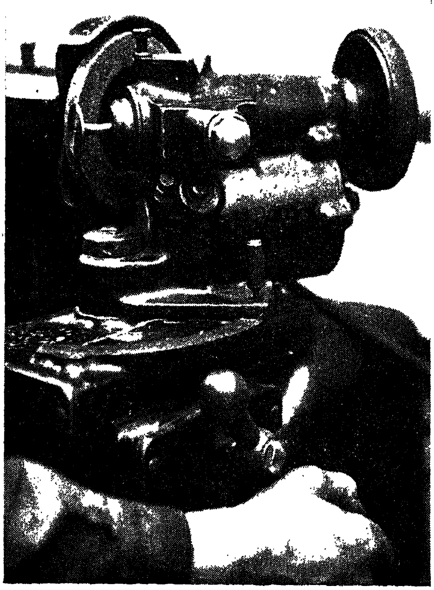


Fig. 8.—VALVE REFACING METHOD AS USED BY THE ROVER CO.

This has been done in three ways on the range of cars under discussion.

On 1934 and 1935 models a Bowden cable is used for operating the clutch. Adjustment is effected in the manner common to Bowden cables, and "dead" movement must be maintained at 1-in., measured at the pedal pad.

On 1936 models a "direct-pull" cable is used, in conjunction with a compression rod anchored to the clutch housing at one end and to the chassis frame at the other. Without this rod, smooth engagement of the clutch would be impossible; it follows, therefore, that if it is allowed to become slack the same undesirable effect would be present.

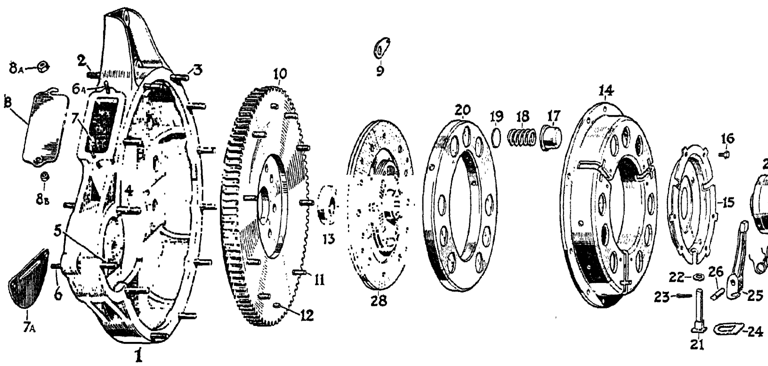


Fig. 9.—EXPLODED VIEW OF CLUTCH, ALL MODELS 1937–39

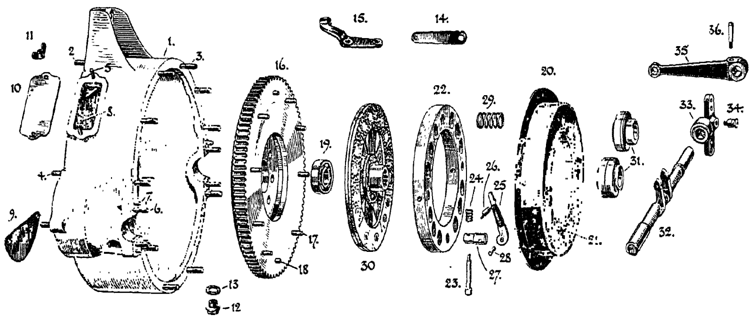


Fig. 10.—EXPLODED VIEW OF CLUTCH, EARLY (1934) TYPE, ALL MODELS, CONTINUED WITH THE ADDITION OF AN OIL DEFLECTOR PLATE UNTIL 1936–7

Clutch Shudder

Should the complaint of *clutch shudder* manifest itself, check the tension of the compression rod, and if necessary tighten it until it can only just be moved. It is provided with an adjustment in the same manner as a track rod, that is, spring-loaded ball joints at either end and a left- and right-hand thread adjustment at either end. The dead movement of the pedal should be maintained at 1-in., measured at the pedal pad. Alternatively, it is sometimes advantageous to convert to the lubricated type of Bowden cable control in order to overcome this trouble, and the necessary parts and instructions can be obtained from the Rover Co. at a low cost.

In 1937 the Bowden cable was reintroduced and was lubricated by the Bijur system, and in 1939 a direct-pull cable working in conjunction with a rod was used and is still being used with great success. When dealing with the complaint of clutch slip on any of the models under discussion, it must be remembered that as all these models are fitted

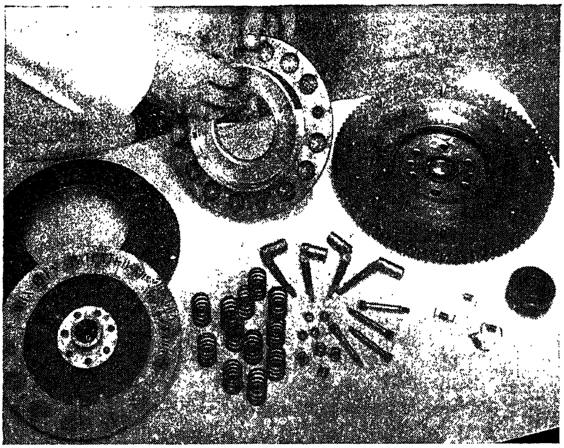


Fig. 11.—CLUTCH ASSEMBLY—ALL CLUTCHES UP TO 1937
1st Stage—fit oil baffle.

with free wheels and flexible engine mountings, methods of diagnosis must necessarily be modified to suit the circumstances, and care must be taken not to confuse the usual causes of clutch slip with conditions caused by one of these two fittings. For instance, a free-wheel slip can be mistaken for clutch slip and vice versa (*see* Free-wheel Slip), and a clutch assembly can be blamed for a fault that rightly should be attributed to the clutch cable (1934–5 and 1937–8 models only).

CLUTCH SLIP—CAUSES AND CURES

In the event of clutch slip being suspected, if the following procedure is adopted no confusion should result.

Causes of Clutch Slip

The presence of one of the following conditions will cause slip.

(1) Incorrectly adjusted clutch-operating mechanism.

(2) Seized, or partially seized, clutch cable (1934–5, 1937–8 only).

(3) Oil on plate due to:

(*a*) Excessive supply of oil to clutch-withdrawal race.

(*b*) Oil passing the rear main bearing.

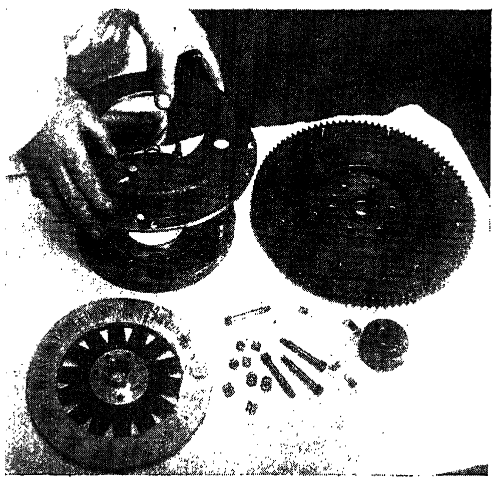


Fig. 12.—CLUTCH ASSEMBLY
Stage 2—fit springs, toggles, and then clutch cover.

(*c*) Over-lubrication of clutch-operating shaft (1933–4 only).

(4) Abuse, leading to overheating and consequent loss of tension at clutch springs.

Proceed as follows:

Check Clutch Pedal for Dead Movement

Check the *dead movement* of clutch pedal; this is most important, because, if the amount prescribed above is not present, the tendency is for the engine movement under certain loads to pull the clutch pedal "in and out" and so cause slip.

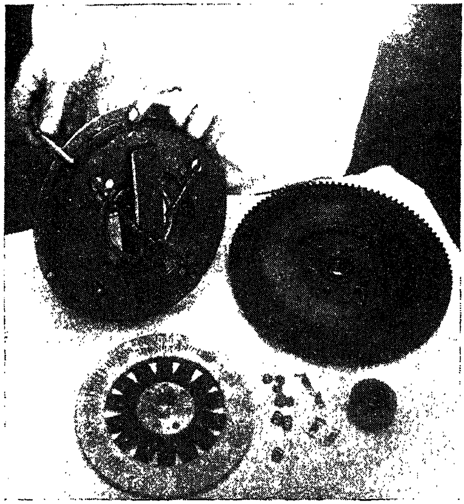


Fig. 13.—CLUTCH ASSEMBLY

Stage 3—with clamp in position, fit fulcrum pins.

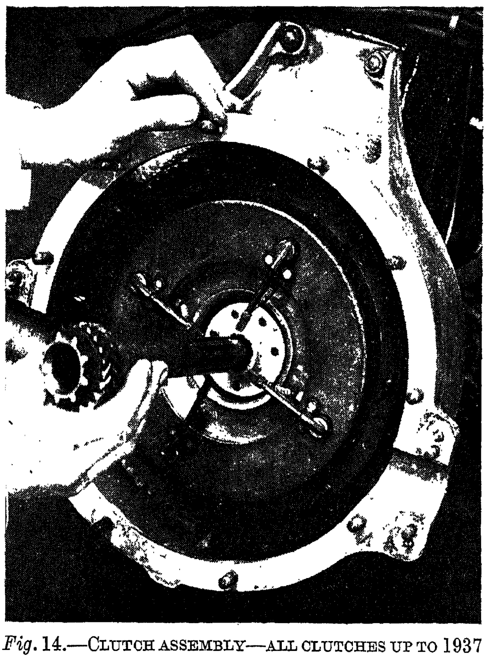


Fig. 14.—CLUTCH ASSEMBLY—ALL CLUTCHES UP TO 1937

Stage 4—check that all toggles are in line and then offer up to engine using an old primary shaft.

Check for Freedom of Operation

If that point is in order, check the clutch operation for *freedom*; if absolute freedom is not present, the engine movement will lead to disastrous consequences in the same manner as described in the previous paragraph. Clutches operated by Bowden cables are the most likely to give trouble in this direction (1934–5) owing to their greater need for ample lubrication. Cables used in 1937–8 are auto-lubricated. If there is the *slightest* sign of stickiness in the operation of one of these cables, the only satisfactory method of correction is to

remove the cable and free it by working thin oil between the cable and casing. On late 1935 models a cable is fitted incorporating a grease nipple, and as this type of cable is used in every instance for replacement purposes on earlier models, they are to be met with on early models also.

Note.—Particular care should be taken when fitting a cable, or fraying of the strands and eventual breakage may occur.

The car should now be taken on the road and tested for slip. If it is still present, the clutch pit should be washed out with petrol. Before doing this it will be necessary to plug the drain hole on the underside. Up till 1934 a drain plug was fitted, but later in 1934 this was omitted and a wooden plug was used. In models from 1935, two drain holes will be found. After plugging these, pour half a pint of petrol into the clutch pit through the timing inspection aperture and then turn the engine over for about one minute by hand, and at the same time get an assistant to operate the clutch in order that the petrol may reach the working surfaces. Now remove the plug, but *do not replace*, even if one was fitted in the first instance.

If the trouble has not now been cured, it will be necessary to remove the gearbox and examine the clutch plate, as it may be found that a new plate is required, due to either oil on the plate or to the plate being burnt.

Oil on Clutch Plate

If oil is found to be causing the trouble, the cause of its presence should be determined also ; causes of oil in the clutch pit may be summarised as follows :

(1) Oil inadvertently added by someone under the impression that it was necessary. This can be determined only by inquiry, or if a large quantity of oil is present, that fact is almost certain.

(2) Over-greasing the operating shaft (1934 models). In that event, signs of this would be apparent upon examining the inner end of the shaft bearings for grease.

(3) Excessive flow of oil from the primary shaft.

The primary shaft is drilled through its centre in order to supply lubricant from the gearbox to the clutch race.

An examination of the shaft will disclose two 3/32-in. holes 180° apart about ½ in. from the end of the splines. If the quantity of oil present in the clutch pit appears to be excessive, sufficient to have caused clutch slip, one of these holes should be plugged with soft wire. The necessity for this modification is not so apparent after 1935, as the clutch from then onwards is fitted with an oil deflector plate. This plate can be fitted to earlier models if required.

(4) The remaining possible cause of oil in the clutch pit is the possibility of a leakage past the rear main bearing, but this would occur only at a very high mileage, and the general condition of the engine would render its detection a certainty.

Fitting a New Clutch Cable

When fitting a clutch cable to any model, care should be taken to obtain correct alignment, or a broken cable may result at a later date.

See that the abutment brackets at the base of the clutch pedal are in line with the cable itself, and having set the bracket correctly be sure that it does not turn when the locknut is finally tightened.

PISTON AND CONNECTING ROD

A split-skirt Bohnalite piston with an Invarstrut has been fitted to most engines (but in some instances Aerolite have been used, especially on 16/20 h.p.), incorporating two compression and two scraper rings. New pistons should be fitted with a clearance of ·0015 in.

Piston removal is possible after removing the sump on both four- and six-cylinder models, but on 14-h.p. six-cylinder models prior to 1938 the pump shaft will also require removal in order to deal with No. 5 piston. The same remarks apply to the removal of connecting rods in order to attend to big-end bearings.

MAIN BEARINGS

All main bearings can be taken up after the removal of the sump, with the exception of No. 1 on the six-cylinder 14-h.p. models. Prior to 1939 it is necessary to remove the timing cover and the front engine-suspension plate to attend to this bearing.

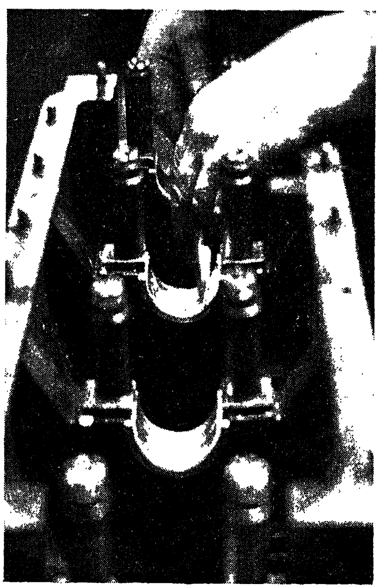


Fig. 15.—SCRAPING MAIN BEARINGS 6-CYLINDER MODEL

WATER PUMPS

All models from the latter half of 1933 are fitted with water pumps mounted on the cylinder head. On six-cylinder 14-h.p. models (except 1939) the pump has a split casing which is attached to the forward face of the cylinder head by countersunk screws inside the casing.

On all other models the pump body is in one piece and is attached by four studs to the cylinder head. In all instances the drive is by endless belt from the crankshaft.

A gland of the self-adjusting thermo-flex type is used for water retention, consequently no attention is required.

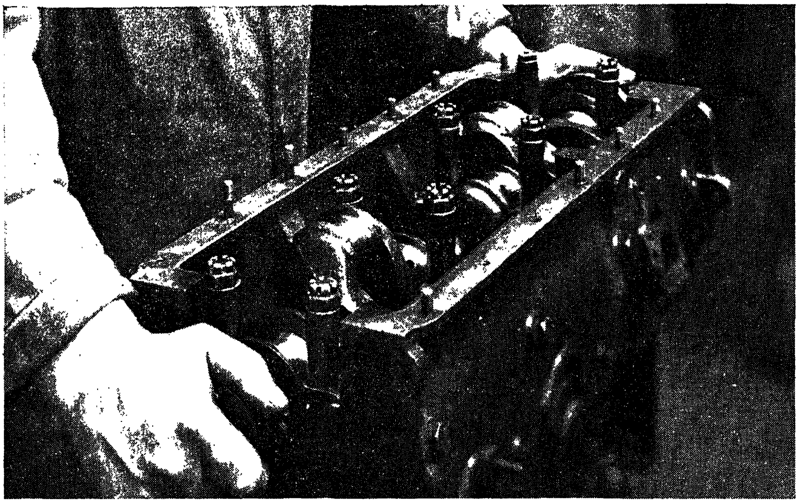


Fig. 16.—FOUR BEARING CRANK ON 6-CYLINDER MODELS

Until 1935 lubrication on this type was carried out with the aid of a grease-gun. In models from 1936, however, the automatic lubrication system is extended to cover this point.

Troubles Due to Lubrication Failure

The failure of adequate lubrication, due to neglect, failure of the automatic system, or a defective gland allowing water to reach the ball bearings, will allow a noise to develop due to the ball bearings becoming rough ; the remedy is to replace the gland, if that is at fault, the ball bearings and spindle, and to check up on the cause of lubrication failure. No difficulty will be experienced in dismantling and reassembling one of these units, but it should be remembered that when assembling a 1936 pump and onwards two ball races are fitted (only one on older models), and between these bearings are located two distance-pieces, one inside the other ; *the inner should be the longer* by ·003 in. The makers favour the system of obtaining a replacement pump unit, because they are then able to supply a replacement that has been tested under service conditions.

ENGINE SUSPENSION (ALL MODELS)

All models are fitted with a " floating " engine suspension, three suspension points being employed, two at the forward end and one at the rear. Adjustments can be made to these points in order to increase or decrease the amount of engine movement and thus overcome any complaint that may arise due to a " period " in the engine. On all models

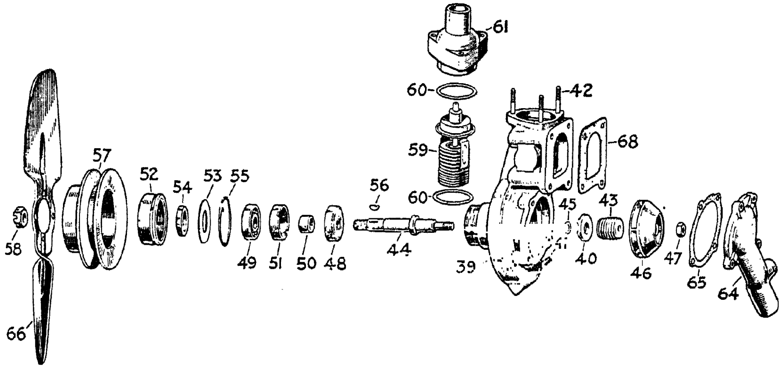


Fig. 17.—WATER PUMP, ALL MODELS 1939

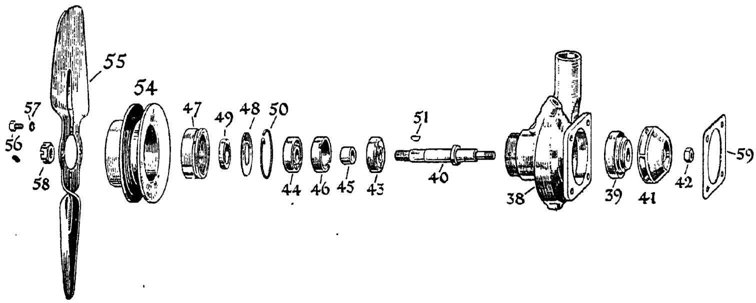


Fig. 18.—WATER PUMP, EARLY TYPE 10, 12, 16, AND 20 H.P.

the engine is retained at the forward end by two bolts passing through a cradle which is bolted to the engine itself and the front chassis cross-member, or on later models through two engine bearers. Between the cross-member and engine bearers are located rubber pads through which pass distance-pieces. It is by reducing or increasing the effective length of these distance-pieces, either by filing the distance-piece or by adding suitable washers, that engine movement is controlled at the forward end. The rear engine suspension is on rather different lines. Instead of the rear end being "hung" in rubber, it is supported on a wide chassis cross-member by a rubber-lined cradle, and kept in check by means of a lined steel strap.

Adjustment of Rear Suspension Strap (1934–8 Models)

On all models using the retaining-strap type of rear suspension it is not intended that this strap should exert a load at its point of application, but it should be tightened only sufficiently to check any lifting movement, yet, at the same time, permit rotary movement.

The result of this strap being too tight would be a rough engine, especially at idling speeds. If it is adjusted in such a manner that a ·010-in. feeler gauge can be inserted between the strap and the free-wheel housing and can be moved round to the full extent of the strap, i.e. 180°, this can be taken as normal clearance. A hacksaw blade can be used for judging the clearance. Tighten the retaining strap until a hacksaw blade can just be passed between the strap and gearcase at any point.

1939-40 Rear Engine Suspension Adjustment

On 1939–40 models conditions are rather different ; the retaining strap is still used, but it is lined with soft rubber and should be tightened just enough to grip without distorting the rubber pads ; *there should be no clearance.*

The adjustable retaining strap has to be disturbed when a gearbox is removed on all models, consequently readjustment becomes necessary when the gearbox is replaced ; if it is not done correctly, it can give rise to intense engine vibration.

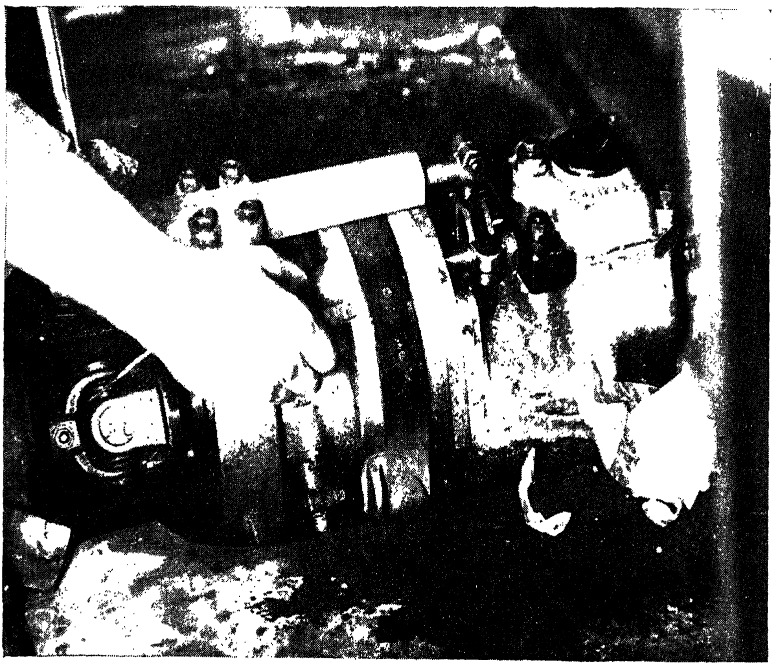


Fig. 19.—ENGINE SUSPENSION (1934–8)
Checking clearance between band and gearcase with hacksaw blade (see text).

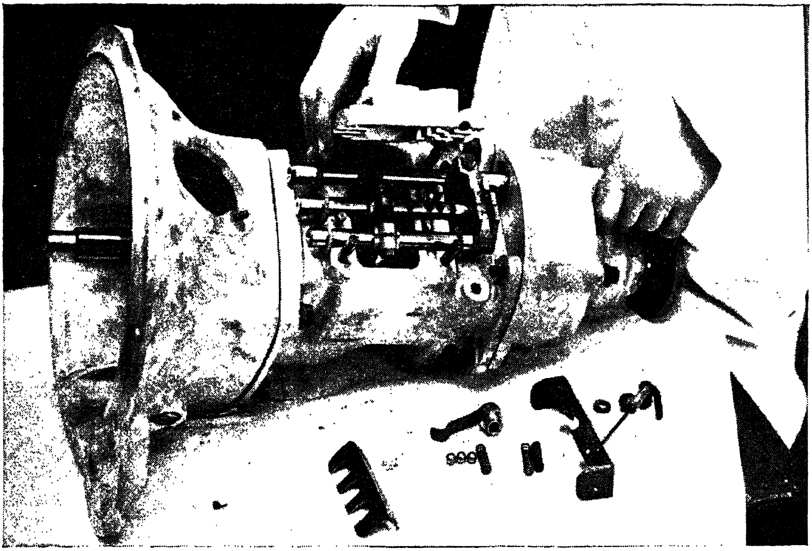


Fig. 20.—DISMANTLING GEARBOX
Remove gearbox lid and take care of the three balls and two plungers (see text).

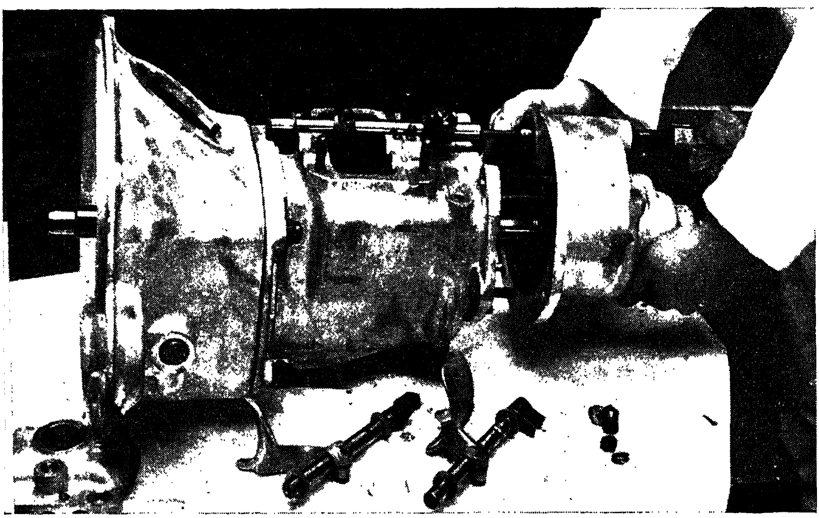


Fig. 21.—DISMANTLING GEARBOX
Withdraw the free-wheel unit rearwards.

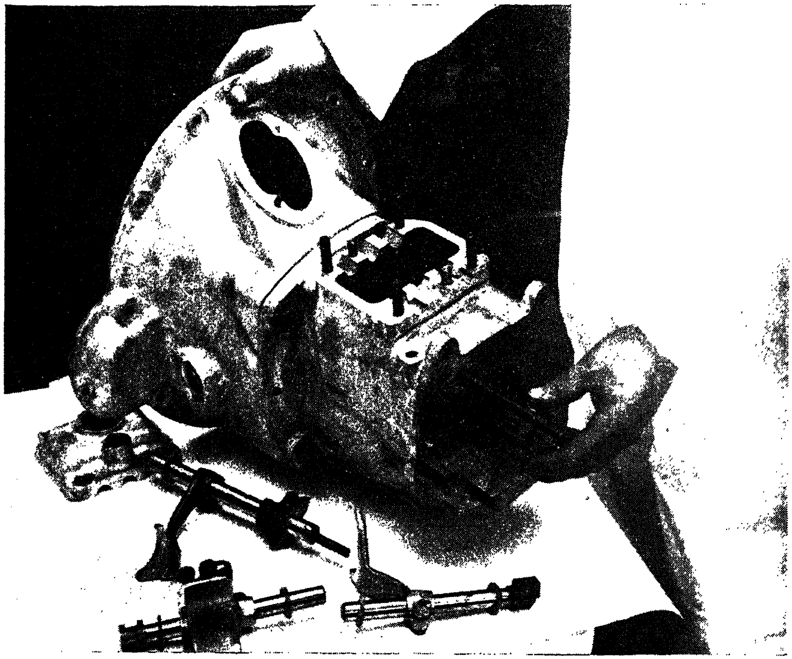


Fig. 22.—DISMANTLING GEARBOX
Remove locknut and washer from rear of mainshaft.

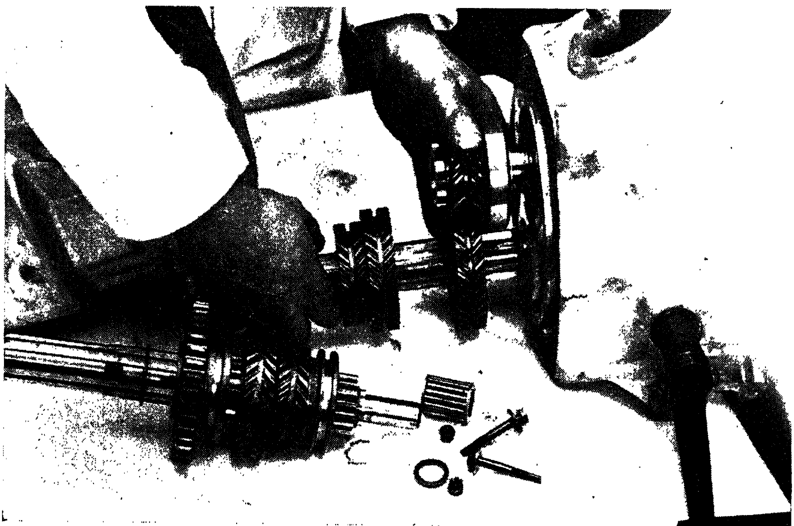


Fig. 23.—DISMANTLING GEARBOX
Examine the gear clusters carefully before removing them from bell housing, and take note of location, etc.

ROVER GEARBOX 1934–40

From the point of view of a service mechanic, the Rover gearbox has changed very little during the past six years, but there are one or two points that require emphasis.

Dismantling

After removing the gearbox lid, remember that there are three selector balls and two plungers—these must all be accounted for and placed in a safe place before proceeding any farther. If that is not done, there is a danger of dropping one or more of them into the box, and in instances where only partial dismantling takes place the loss might remain undiscovered until damage had been caused—to say nothing of inconvenience and loss of time. Having done this, release the ring of nuts retaining the freewheel assembly and withdraw rearwards.

The locknut and washer should then be removed from the mainshaft and the four large nuts retaining the bell housing to the gearcase—the gearcase can now be withdrawn from the bell housing and, if care is taken in applying a lead hammer to the rear end of the mainshaft, the gearcase will come away leaving the gear clusters in position in the bell housing. At this juncture it is good practice to carefully examine the assembly before disturbing and take particular note which way round the gears sit, the presence or absence of thrust washers, etc., and their location—because these points vary from year to year and a lot of time will be saved when reassembly is attempted. When satisfied regarding this point, remove the main- and layshafts rearwards and then the primary shaft can be driven out rearwards, but do not forget to remove, on all models after 1934, the split ring locating the primary shaft and the two $\frac{1}{4}$-in. bolts retaining the primary shaft bearing.

If it is necessary to remove the reverse shaft, it is threaded $\frac{3}{8}$ B.S.F. for using an extractor.

All these remarks re dismantling apply to every model under review, but when reassembling it is necessary to devide them into two groups.

To Reassemble 1934–8

Build up the primary, main-, and layshafts into the bell housing and watch the following points :

1. See that all gear are in full mesh, because it is possible to fit the gears half-mesh only, and the result will be—sooner or later—broken teeth. The box will run quite well and will not even be noisy, consequently it will not be detected until it is too late.

2. Support the bell housing in a vice and offer up the gearbox to the loaded bell housing and at the same time keep the primary shaft slowly turning and *do not use any force.* To replace the remaining parts, merely reverse the dismantling operation.

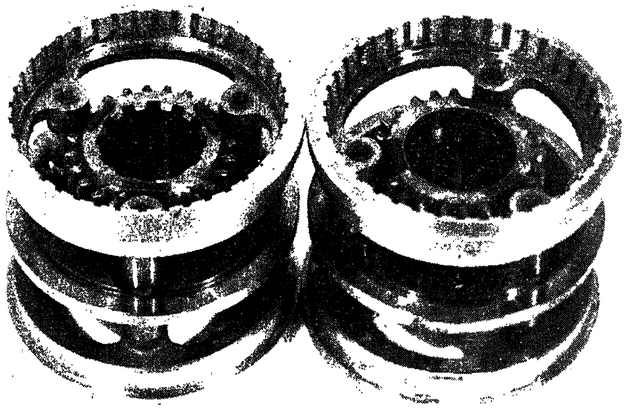


Fig. 24.—SYNCHRO-CLUSTER ASSEMBLY—RIGHT AND WRONG
The recessed portion goes to third gear.

To Reassemble 1939–40

As synchromesh is used on these models, assembly is somewhat different.

Instead of assembling all gears into the bell housing, as in the previous models, assemble all gears on their respective shafts and assemble into the gearcase itself with the exception of the synchro cluster—leave that until last—and when the mainshaft is in position enter the synchro cluster with the recessed end of inner portion *towards the third speed.* This is most important, and if not carried out correctly may result in a cracked bell housing.

Fit the primary shaft to the bell housing and then support the gear-case in a vice and offer up the *bell housing* to the loaded *gearbox*—just the opposite to the procedure on previous models.

Broken Tooth

As previously mentioned, a broken tooth can be caused by fitting gears half-mesh only. It would result in a knock from the gearbox, but it would only occur when the *layshaft was under load.* If the knock occurred on all gears except top, the broken tooth would be on the constant wheel; if it occurred on first, second, or third gear it would be either main- or layshaft wheel on that particular gear—so take great care in assembly.

There are other causes of broken teeth, of course—such as foreign matter in the box; so watch that point also.

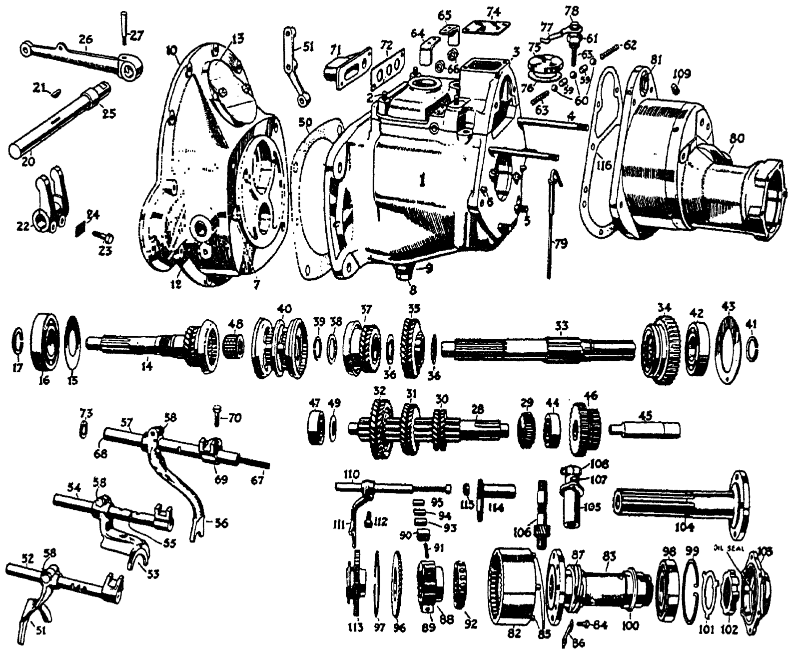


Fig. 25.—LATEST PATTERN GEAR ASSEMBLY, 1939–40 (SYNCHROMESH)

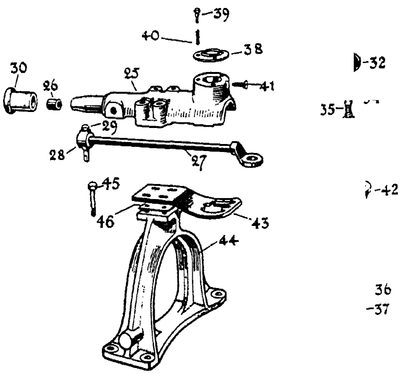


Fig. 26.—THE CHANGE-SPEED MECHANISM AS DESCRIBED IN THE TEXT

Slipping Out of Gear

On all models this is almost invariably due to alignment of the selector mechanism, and it can be dealt with much more readily if it is remembered that the change-speed mechanism is not mounted on the gearbox itself but direct to the chassis frame; thus relative movement can take place between the gearbox assembly (flexibly mounted) and the remote-control assembly (rigidly mounted).

In order to obtain correct alignment, the change-speed gate is fitted through elongated holes, thus permitting fore-and-aft adjustment, as is also the remote-control support turret at the point where it is bolted to the chassis frame.

The first thing to do upon receipt of a complaint of this nature or

upon refitting the gearbox assembly, is to check each gear separately, in order to ensure that the selector finger does not approach the end of each slot by anything less than $\frac{1}{8}$ in.

If it is found that fouling is taking place, or the $\frac{1}{8}$-in. clearance is not obtained, adjust the gate through the elongations provided, but take care that when obtaining more movement in one direction by adjusting the gate that fouling is not caused in the opposite direction.

If such should be the case, it will be necessary to remove the gate and elongate the slots in the required direction with the aid of a round file.

It is sometimes found that slipping out of gear is due to the change-speed lever being required to adopt an abnormal angle, due to the support turret of the gate being too far backward or forward. This will mean that the universal joint on the change-speed lever is attempting to adopt a technically impossible angle—to correct matters, centralise the turret in order to reduce the angle and file the slots as necessary.

REPAIR NOTES ON JOWETT ENGINES

By J. EARNEY

TWIN ENGINE

BECAUSE the Jowett layout is unorthodox compared with the majority of other cars, many are apt to be a little apprehensive of taking on a repair job that may entail a fair amount of dismantling. Actually they are very straightforward from a repair point of view, and certainly more accessible than many.

The general design has remained constant from its introduction, and these notes will apply to most models in use to-day. The horse-power of the engine was increased from 7 to 8 in 1937 by increasing the bore, otherwise alterations have been confined to details.

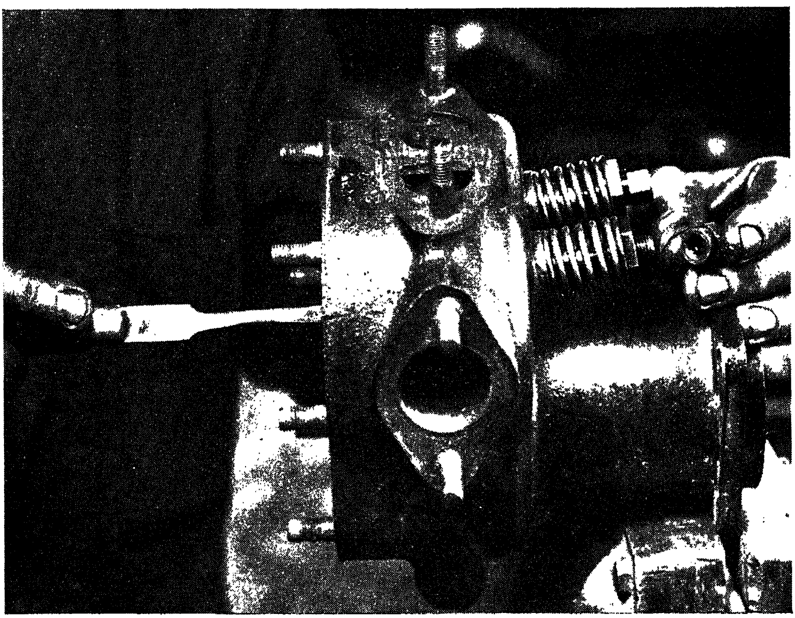


Fig. 1.—REMOVING VALVES
The adjustable tappet nut has just been unscrewed.

Dismantling

The first operation is to drain off the water by removing the hexagon-headed drain plugs which will be found on the underside of each cylinder. Removing both front wheels discloses an inspection plate inside each front wing; remove these and the cylinder-head nuts are readily accessible.

Unscrew the six head nuts and the head can be drawn off the studs. Should this be at all obstinate, screw an old sparking-plug body in place of the one in use and tap lightly with a hammer until the joint with the cylinder is broken.

Valves

Having removed the head the valves can be taken out. These are enclosed by aluminium covers, or sheet metal in the earlier models, which can be taken off. Although not absolutely necessary, it may save a great deal of time and patience if the flywheel pit is covered up. It is surprising, the attraction that it affords to unattached small parts.

The valve stems are screwed at the end into two hexagon nuts. The smaller of these provides the adjustable clearance for the tappet, the larger is the locking nut and also the cup for the valve spring. Normally these are locked together, and if they are slackened the valve can be withdrawn by unscrewing with a screwdriver in the head of the valve. Now lift out the two nuts and spring—remember the latter is in slight compression.

Decarbonising

The engine is now dismantled for decarbonising and grinding in valves, which can be carried out in the usual manner.

Removal of Engine

For a complete overhaul to the engine it is necessary to take it from the chassis.

Radiator

If you are using block and tackle or a crane it is not necessary to remove the radiator. If, however, these facilities are not available, then the removal of the radiator will give greater freedom to lift out the unit by hand; in any case take the radiator tie-rods away. If the cylinders are removed first, you will have much more freedom in manœuvring the crankcase, and less weight to handle. In doing this you will deprive the unit of its mounting on either side. Provide support, therefore, by a stout board between the head of a jack and the sump, screw up the jack until the weight of the engine is just taken; engaging the starting handle will give an additional safeguard.

To avoid damage, disconnect the coil and take off from the dynamo, withdraw the distributor, label dynamo wires and disconnect these, together with battery, horn, and oil-pressure pipe.

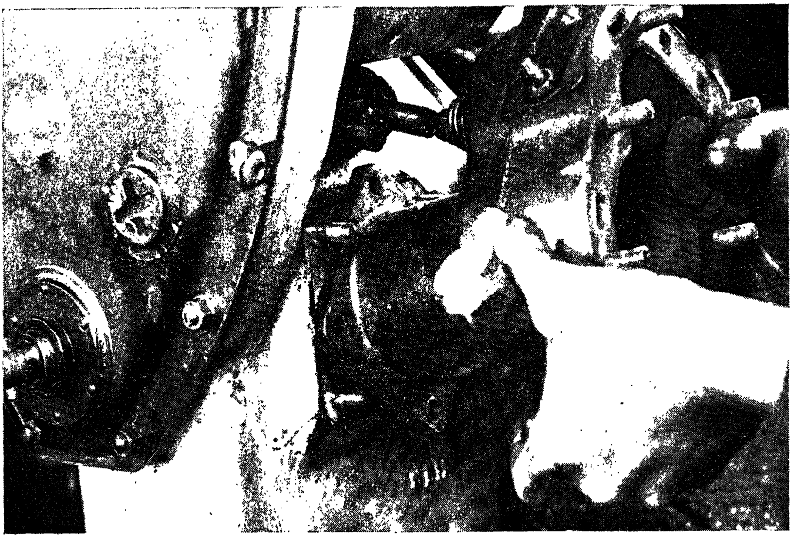


Fig. 2.—Removing the cylinder

Now detach the throttle rod, strangler wire, and petrol pipes, draw off water hoses, and take off induction pipe with the carburettor complete. Then remove the exhaust system—on models with a flexible section joining the silencer it is advisable to disconnect at this end first, to avoid fracturing the joints. Frequent heating and cooling causes the joints of the metallic tubing to become very brittle.

Steering Column

The next operation is to remove the steering column; this will give greater access to the offside cylinder. Slacken the support on the fascia board and the clamping bolt of the steering box, wedge open the clip with a screwdriver, and this will allow the column to be withdrawn clear of the engine and secured out of the way.

Engine Mountings

Having made sure the crankcase is adequately supported, the mountings on either side can be removed. Whilst not essential, it is an easy matter to remove the mountings as a complete assembly and thus offer a good opportunity for overhauling. Note there is a washer between the mounting body and the chassis frame on the nearside.

Cylinders

Removing the four base nuts will leave the cylinder ready to be lifted off. Now, supporting the cylinder with the right hand, turn the flywheel

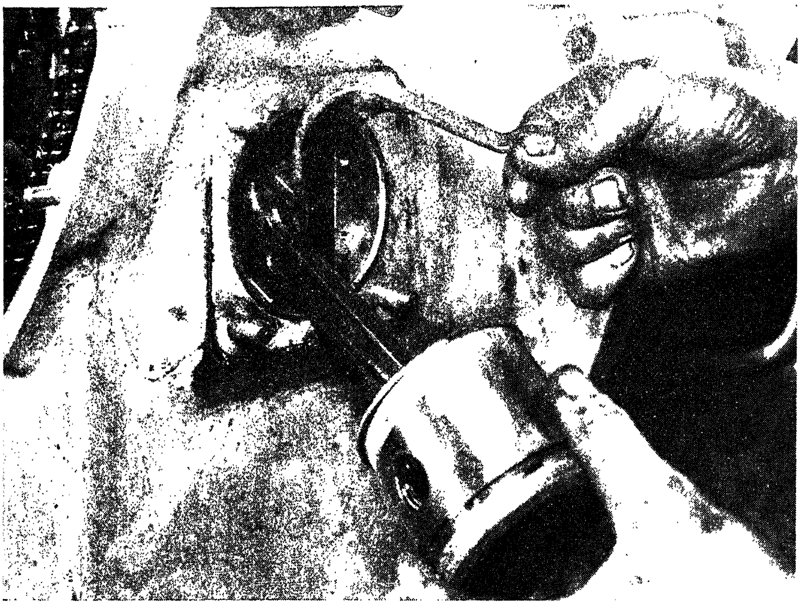


Fig. 3.—WITHDRAWING CONNECTING RODS
Showing hook used to steady cap when rod is withdrawn.

until the piston is half-way down the stroke, slide the cylinder clear of the studs, turn to the left an eighth of a turn, and so bring the corners of the flange diamondwise between the studs of the crankcase. Now push it back to the crankcase, at the same time tilting upwards to clear the chassis frame ; it may be necessary to ease the engine towards the opposite side to give a little more clearance. Remove the opposite side in a similar manner.

All that remains now is to take out the bolts round the flywheel housing, draw the unit forward until clear of the gearbox mainshaft, and lift out of the chassis.

Removal of Connecting Rods

The next job is the removal of connecting rods, and it will be found easier to take off the pistons afterwards. Proceed to remove the baffle plates either side of the crankcase mouth. The following simple tool will be found of material assistance—make up a hook from a piece of flat, mild steel, say $\frac{1}{2}$ in. by $\frac{1}{8}$ in. Shape it to conform to the big-end cap. This is used to hold the cap, with the bolts, against the shaft journal, after the split-pins, nuts, and washers have been removed, thus allowing the rod to be withdrawn without the cap and bolts falling back into the crankcase. Afterwards the cap and bolts can be coaxed round the shaft and lifted out.

Dismantling the Clutch

The outside toggle-plate has been balanced, so mark it in relation to the arrow on the flywheel. Undo the six setscrews a few turns each, at the same time take careful note if the plate is following the screws. Due to an accumulation of dust from the fabric plates and oil these occasionally stick. If the screws are then removed entirely, the plate will subsequently fly off in a rather alarming manner. So if the plate is not following the screws as they are being undone, put a lever behind the toggle fulcrum pin, against the setscrew, and lever free. Now remove the centre plate and dismantle the clutch. Check pressure and guide pins for wear.

Timing Gear

Remove the timing cover and unscrew the starting-handle dog—a sharp punch against the direction of rotation will usually shift this. Now lift off the oil gland and undo the crankshaft nut (right-hand thread). If the valve timing is not marked, do so by rotating the flywheel until the arrow is at top dead centre, and marking with a centre-punch the lowest tooth of the camshaft sprocket and the highest tooth of the crankshaft sprocket which is opposite to it, as indicated in the diagram on p. 306.



Fig. 4.—WITHDRAWING CONNECTING RODS
Hook in position and rod being withdrawn.



Fig. 5.—WITHDRAWING CONNECTING RODS
Cap with bolts being lifted out.

The timing chain and dynamo can now be removed. The crankshaft sprocket is fitted on a taper and will respond to the usual sprocket drawer. Make a special note of the position of the sprocket key. It is offset to take up any wear or stretch in the chain. If necessary, the camshaft sprocket can be removed by two extractor bolts screwed into the threaded holes.

Withdrawing the Crankshaft

You will find it much easier to part the flywheel from the shaft after the latter has been taken from the crankcase, so undo the nuts at the back of the flywheel and lift the flywheel, with the rear main bearing housing, away from the crankcase, drawing the crankshaft with it. Then, holding the flywheel with the rim in a vice, separate from the shaft by means of an extractor. This can be made up from a steel plate about 8 in. diameter and $\frac{3}{4}$ in. thick. Drill two clearance holes to accommodate the extractor bolts.

Lubrication System

The oil pump can now be inspected ; undo the four nuts underneath the crankcase sump at the front end. Now insert two $\frac{1}{4}$ in. by 26 T-bolts into the two tapped holes turn and turn about. This will draw the pump assembly from the housing complete. Do not take out the two countersunk screws until the pump is withdrawn. These can then be taken out to dismantle the pump.

On the nearside, at the bottom of the crankcase, will be found the filter. After the flange nuts have been undone this can be taken out by lightly tapping behind the lugs provided.

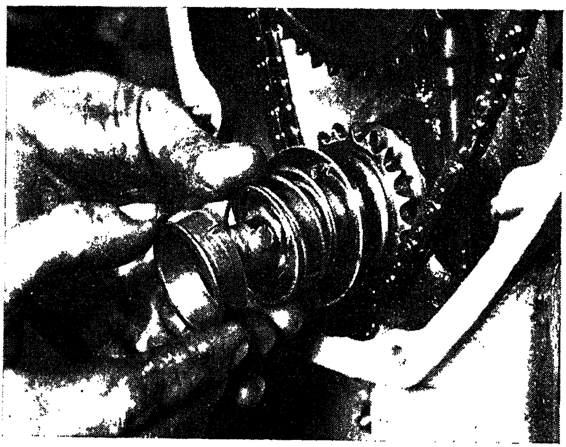


Fig. 6.—DISMANTLING TIMING GEAR
Showing the oil gland.

Pressure-relief valve can be removed by the centre bolt, taken apart, and cleaned. Pressure can be adjusted by the slotted adjusting screw—screwing in increases pressure.

Tappets

Undo the nut and bridge-piece, when a screw-

driver as a lever, behind the flange, will usually release the guide. Examine the tappet bases for signs of wear.

Reassembling

This is largely a reversal of the dismantling order; the following points, however, should be borne in mind. Clean out the oil-ways by removing the hexagon plugs and washing through. When refitting the filter it is most important to ensure the lug marked TOP is so fitted. Make certain the oil-return holes in the timing case and rear-bearing housing are clear.

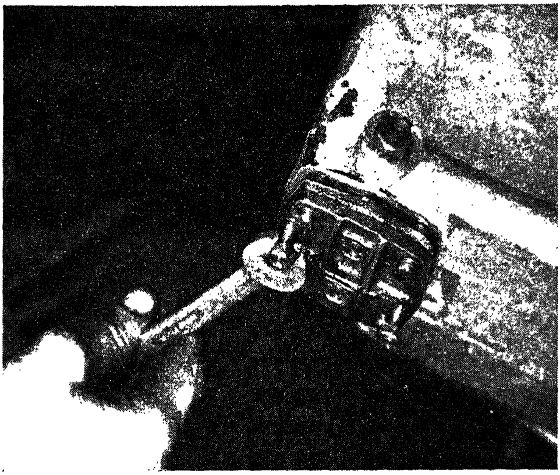


Fig. 7.—WITHDRAWING OIL PUMP

Two setscrews are being used to draw the assembly. Note also the two countersunk screws.

Main Bearings

See the main bearings—white-metal bushes—are tight and show no signs of moving against the dowel pegs.

Breather Valve

This is in the oil-filler neck; undo the centre-bolt nut, thoroughly clean all parts, particularly the return hole into the crankcase. It is recommended to fit new star discs and be sure the points cover the breather holes.

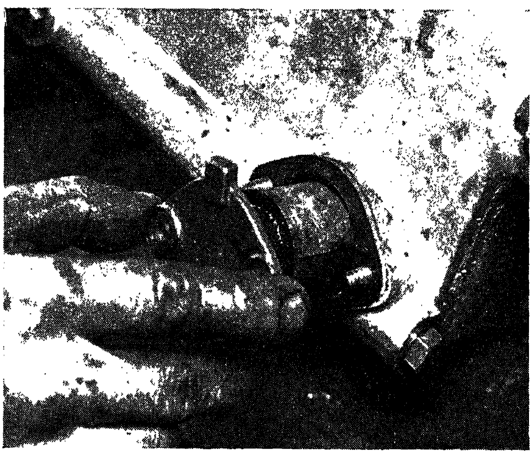


Fig. 8.—OIL FILTER

Note lug marked TOP. See also the hexagon plugs sealing the oil-ways.

Oil-level Indicator

This is a wire on a cork float. See this

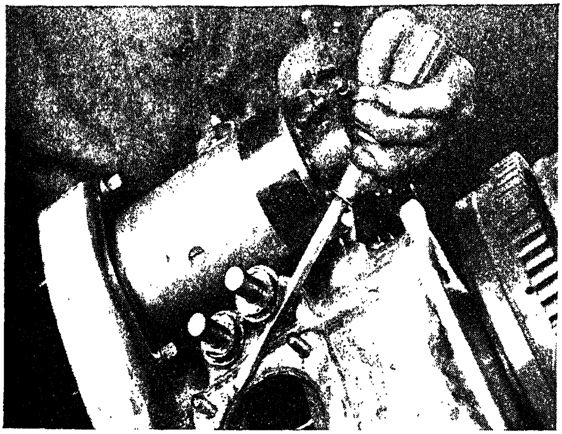


Fig. 9.—REMOVING TAPPET AND GUIDE

works freely in the guide, a nutted stud below the timing case towards the offside. A new indicator is inserted from the flywheel end. Never check the oil level when the engine is running—there is a danger of the crankshaft balance-weights fouling the wire.

Tappet Guides

The inlet tappet guides are marked with a line on the flange ·this should be uppermost. The inlet tappet is the one that is drilled.

Big-end Bearings

Take up any play and mate these to the journals before the crankshaft is refitted. Fit the connecting rods after the shaft is in position. Big-end bolts are retained by a single-spring washer, plain nut, and split-pin, in this order. Always replace washer and split-pin with new parts.

Pistons

All 7-h.p. pistons are fitted with a gudgeon-pin retaining band. The pin is a "drive-in" fit in the connecting rod, and a floating fit in the piston bosses. 8-h.p. pistons have bushed connecting-rod small ends, full floating pins, and circlips.

Reassembling Clutch

When reassembling you will find the setscrews are too short to start in the thread owing to the pressure of the springs. Use two of the fly-wheel-housing bolts to compress the springs, temporarily, until the other four are in position. Note the small dowel for the setscrew plates.

Adjust the toggle levers by means of adjusting screw and locking nut to give at least $\frac{1}{16}$-in. play before contact with the thrust race, and about $\frac{1}{2}$-in. free movement on the clutch pedal before it commences to operate.

Valves

It is important these are in the correct order. The exhaust is made of special steel and has a rounded head, whilst the inlet has a flat head

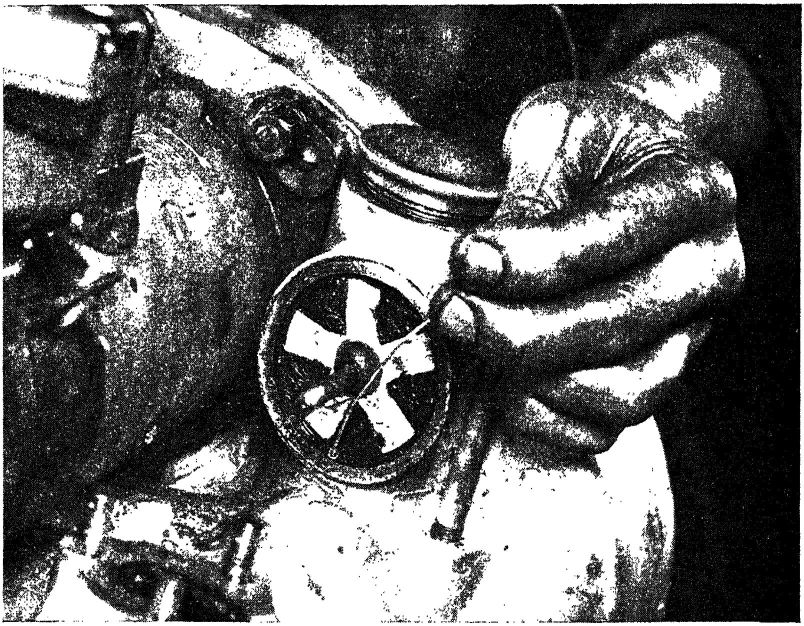


Fig. 10.—BREATHER VALVE
Clearing the oil-return hole.

and is partially drilled down the centre of the stem. The guides are a press fit in the cylinder, and the small hole in the collar should be underneath.

Engine Mountings

Prior to 1935 these consisted of rubber washers. Since this date suspension has been by means of a shock absorber on the hydraulic principle. It is advisable to dismantle these, and inspect the compression springs before refitting. Thoroughly clean and fill with engine oil. Be sure to replace the washer under the nearside mounting. Top up frequently with engine oil: in the 1935 model by lifting up cup washer on the top of the reservoir; 1936-7 type by removing the small grub-screw in the top housing; with later models by lifting up a rubber sleeve. In this latter type check the ball valve underneath the hexagon plug.

Valve Timing

Proceed as follows—set tappet clearances to ·012 in. With the flywheel at top dead centre—i.e. arrow mark on flywheel in line with similar mark on top of crankcase, set either inlet valve to be on the point of opening. The distributor should then be set with the

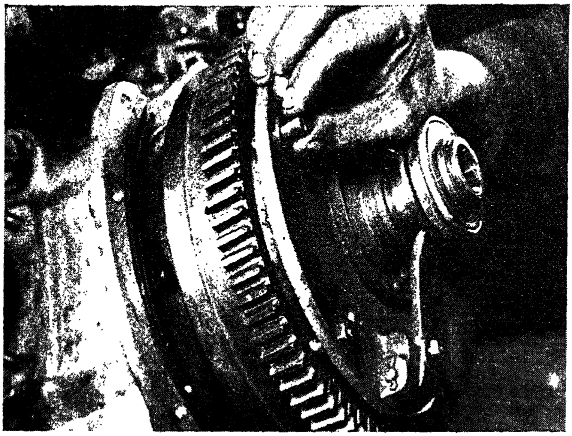


Fig. 11.—REASSEMBLING CLUTCH

Two flywheel bolts have been used to compress the clutch plates. The clutch setscrew is then able to pick up the thread.

contact points just breaking and the rotor firing the opposite cylinder —e.g. if inlet valve is opening on off-side then rotor should be firing nearside. Then reset all tappets to a running clearance of ·006 in. On all engines previous to number 643100 the tappet clearance for timing is ·006 in. to be reset to ·002 in. for running.

Tappets

When setting tappets always be sure the engine is quite cold and the valves off the lift; to ensure the latter, adjust an inlet when the inlet in the opposite cylinder is at the top of its lift, and similarly with the exhaust.

Coil

When refitting the coil to the dynamo make sure the washers are replaced under the heads of the base-flange bolts, otherwise there is a possibility of the bolts going through and fouling the field coils.

"FLAT FOUR" ENGINE

Generally speaking, the 10-h.p. four-cylindered unit differs very little from the 8-h.p. twin, as far as overhauling and dismantling are concerned, and the same instructions largely apply.

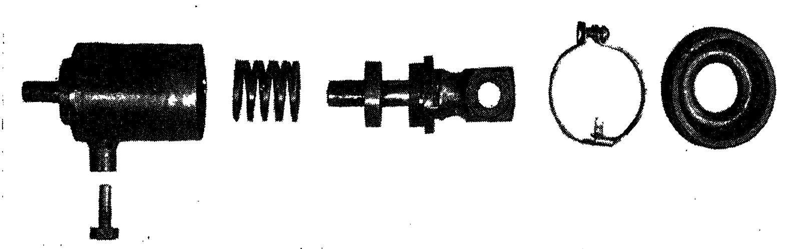


Fig. 12.—ENGINE MOUNTING—LATEST TYPE DISMANTLED

Showing order of assembly. The hexagon plug contains the ball valve.

Dismantling

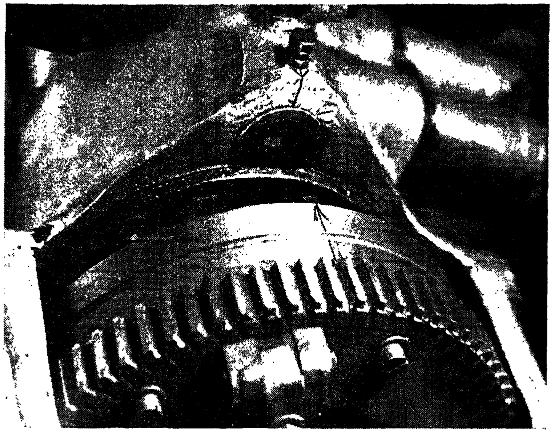


Fig. 13.—T.D.C.

Showing the arrow on flywheel in line with marking on crankcase.

It is preferable to remove the water connections on the cylinders rather than the hoses. When removing the unit out of the frame, the steering column can be drawn forward sufficiently to clear the engine. To do this, loosen the dash bracket clip and remove the anchor bolt securing the steering box to the chassis cross-member. This will avoid disturbing the steering-wheel switch gear.

Cylinders

When removing the cylinder blocks, a certain amount of binding on the base studs may be experienced. To avoid this, undo the five bottom nuts, leaving the top one until last. Support the block when removing this one, and draw the block straight off. The tappet assembly will come away with the block and can be removed as an assembly. Valves can be removed as advised for the twin engine. The heads of inlet and exhaust differ in diameter. The gudgeon pins are fully floating —it is advisable to remove the pistons to avoid damage.

Engine Mountings

These are solid rubber; it is not necessary to remove them when taking the engine out. Slacken off the centre bolt, remove the bolts from the crankcase, when the mountings can be swung clear.

Timing Gear

There is no spring link in the timing chain, so loosen the dynamo sprocket, slacken the dynamo bolts, and slide the dynamo clear until the sprocket drops down; the chain can then be removed.

Crankshaft

When this is withdrawn, examine the oil pipes conveying the oil to the journals for possible fracture or looseness where they are brazed into the shaft. This sometimes accounts for a loss of oil pressure.

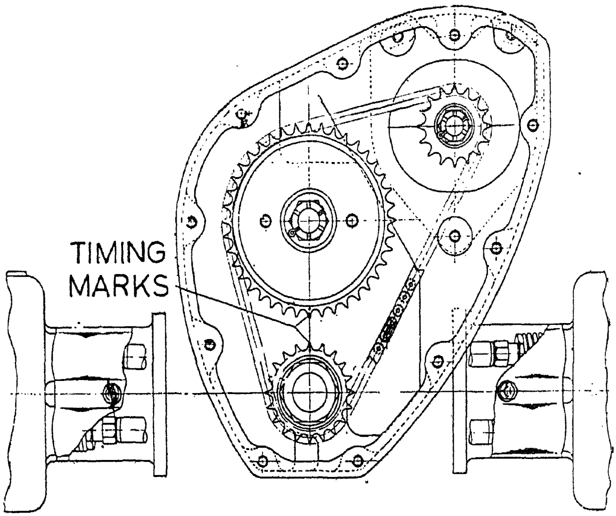


Fig. 14.—TIMING MARKS ON CRANKSHAFT AND CAMSHAFT SPROCKETS (TWO-CYLINDER ENGINE)

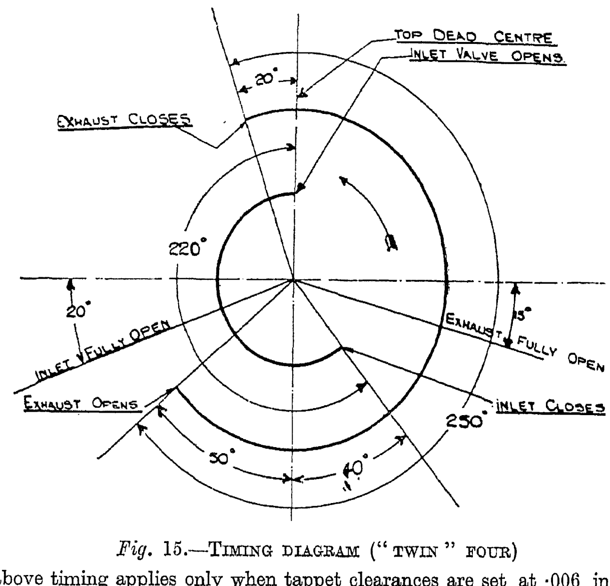


Fig. 15.—TIMING DIAGRAM ("TWIN" FOUR)

The above timing applies only when tappet clearances are set at ·006 in. or ·012 in. according to engine number.

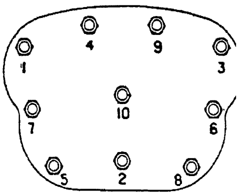


Fig. 16.—ORDER OF TIGHTENING NUTS 10-H.P. CYLINDER HEAD

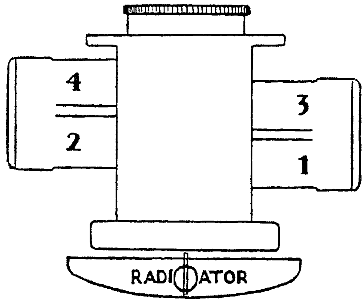


Fig. 17.—10-H.P. CYLINDER NUMBERING DIAGRAM

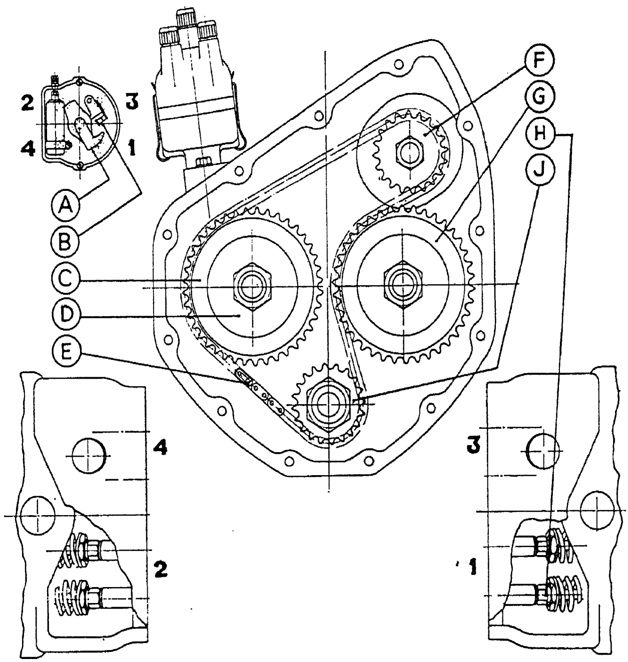


Fig. 18.—TIMING CHAIN ("FOUR" ENGINE)

A, contact-breaker segment firing cylinder 1. B, contact-breaker points just breaking; C, camshaft sprocket 2/4. D, vernier peg plate. E, timing chain spring link for removal. F, dynamo sprocket. G, camshaft sprocket 1/3. H, cylinder 1 inlet valve just opening. J, crankshaft sprocket.

Valve Timing

The cylinders are numbered as follows :

No. 1. Nearside front. No. 2. Offside front.
No. 3. Nearside rear. No. 4. Offside rear.

Fit timing chain and dynamo sprocket and secure dynamo in position. Now set all tappets to a ·012-in. clearance in the manner recommended for the 8-h.p. engine.

The camshaft sprockets have a vernier adjustment by two side plates ; undo the sprocket locking nuts and take off the outside plates. Now rotate the flywheel to the top-dead-centre position, marked T.D.C. 1/2 on the rim in line with the arrow on the crankcase. Set the nearside camshaft for cylinders Nos. 1 and 3, so that the inlet valve on No. 1 cylinder is just about to open. Refit the vernier plate and tighten up the locking nut. Then turn the flywheel one complete revolution, and carry out the same procedure to No. 2 cylinder, with the offside camshaft for Nos. 2 and 4 just about to open the inlet on No. 2 cylinder, locking up with vernier plate and nut. Now set the ignition timing.

Ignition Timing

With the flywheel still at the T.D.C. 1/2 position and the inlet valve just about to open on No. 2 cylinder, the No. 1 cylinder will be on the compression stroke, so the contact-breaker points should be just opening with the rotor firing No. 1 cylinder. Fine adjustment can be made by slackening the screw locking the quadrant plate beneath the distributor and advancing or retarding the distributor body as required. Readjust all tappets to a running clearance of ·006 in.

ENGINE VIBRATION DAMPERS

ALTHOUGH the reciprocating parts of the present-day engine are very carefully balanced, there is always a certain amount of vibration at various periods. This vibration is most pronounced when the engine is accelerated suddenly, and in order to eliminate this a vibration damper is fitted.

The damper is fitted on the front end of the crankshaft, and actually consists of an automatic clutch in a flywheel. These dampers are divided into two classes: (1) the multiple-plate type, which runs in oil, and (2) the friction-disc type.

Multiple-plate Vibration Damper

A typical example of the multiple-plate vibration damper, and actually the forerunner, is the one designed by Dr. Lanchester.

Maintenance

Figs. 1 and 2 show the front and rear views of the complete assembly, which is held on the crankshaft by a key, and locked by the starting-handle dog. Except for periodical topping up with oil, there is no maintenance. There are two plugs on the outside circumference of the casing, and the engine should be turned until one of the plugs is at the

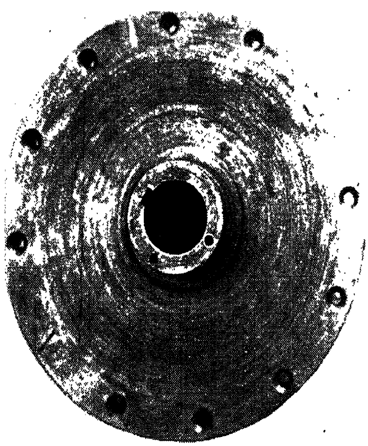


Fig. 1.—Front view of multiple-plate vibration damper

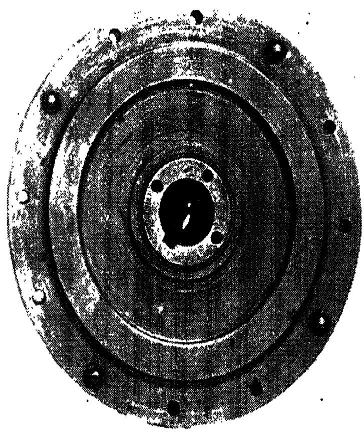


Fig. 2.—Rear view of multiple-plate vibration damper

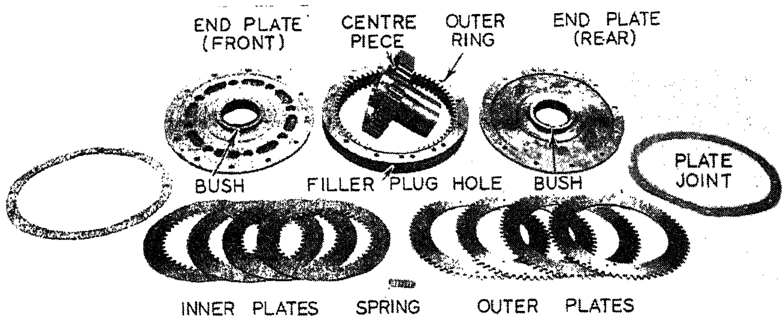


Fig. 3.—MULTIPLE-PLATE VIBRATION DAMPER SHOWN DISMANTLED

top, and with the aid of a box-spanner it can readily be removed. On some models the plug is countersunk and fitted with a square head, and a special box-spanner is provided in the kit for removing. Heavy gear oil should be used for topping up, and it is advisable to warm the oil slightly before filling the oil-gun. Always replace the plug securely after filling.

Providing the damper is not allowed to run dry, very little trouble will be experienced during the life of the engine, and it should receive attention only when the engine is completely overhauled.

Operation of Damper

The actual working of the damper is very simple, and reference to illustrations will do more to explain it than a long article. When the engine is running at an even speed the damper revolves as a solid mass, but as soon as the engine is suddenly accelerated the plates are forced apart, causing a certain amount of slip, which absorbs the vibration.

To Dismantle

As stated previously, the damper is held on the crankshaft by the starting-handle dog, which when removed will allow the complete assembly to be withdrawn from the crankshaft. In some cases it can be withdrawn by using two long levers, but a far more satisfactory way is to use the correct withdrawal tool.

Once the assembly is on the bench it is quite a simple matter to dismantle. First drain out all the oil by removing one of the plugs, and then undo the nuts round the other casing evenly and progressively. When all the nuts and washers are removed the whole assembly will then come to pieces. Wash all the parts in paraffin, and after drying examine for wear. The following points should be closely watched:

(1) Examine the plates. Any sign of distortion will cause the damper to stick, and the faulty plate (or plates) should be scrapped.

(2) See that the plates are an easy fit in the outer casing and on the centre-piece.

(3) The springs should be of an even tension, and it is advisable to fit a new set.

(4) Examine the two brass bushes. These should be a good fit on the shaft.

(5) Thoroughly clean off the faces of the front and rear covers, also the outer ring. Washers are fitted between these faces, and these may have been broken upon dismantling.

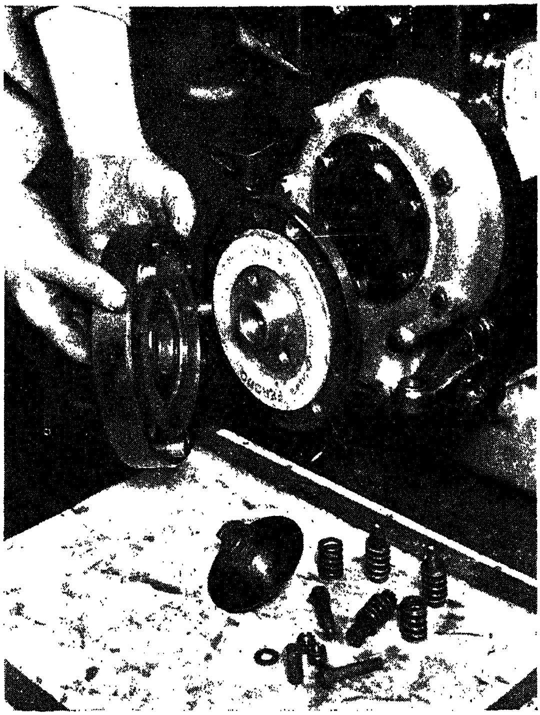


Fig. 4.—FRICTION-DISC TYPE OF DAMPER
Showing removal of friction disc of damper Triumph car.

Reassembly

Reassembly is just reversing the dismantling operations. Care should be taken when fitting the front endplate and nuts. The nuts should be tightened evenly in order to pull the plate down square.

After filling with clean gear oil the damper is ready for refitting to the shaft.

Friction-disc Damper

The friction-disc damper is similar in design and operation, but requires no maintenance whatsoever, being similar to a " dry " clutch. The component parts consist of front and rear outer plates, friction discs (usually two), damper centre, springs, and two bushes.

The dismantling details are similar to the operations carried out with the multiple-plate type, and the only difference is the examination of the friction discs. If the discs show any signs of glazing or burning it may be possible to clean them up, but a more satisfactory method is to replace the plates with new ones.

Although this type of damper is designed so that foreign matter

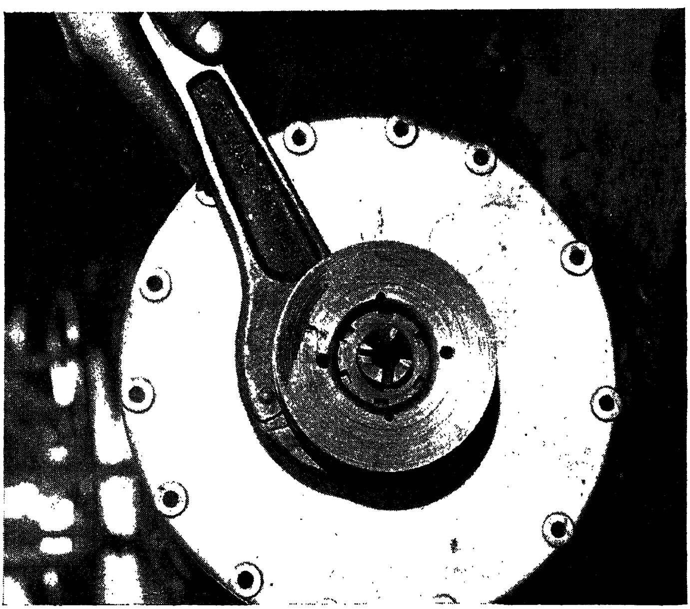


Fig. 5.—AN ADJUSTABLE VIBRATION DAMPER
Showing the method of adjustment.

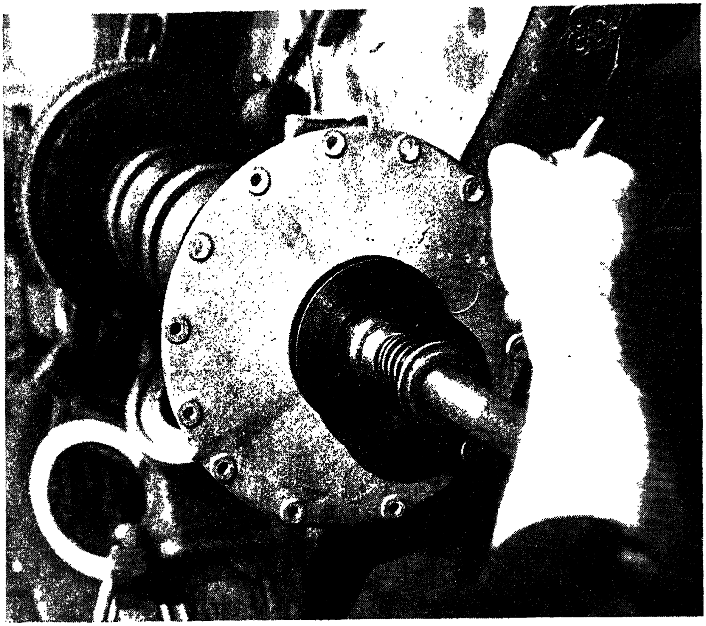


Fig. 6.—ADJUSTABLE VIBRATION DAMPER
Removing damper locking nut.

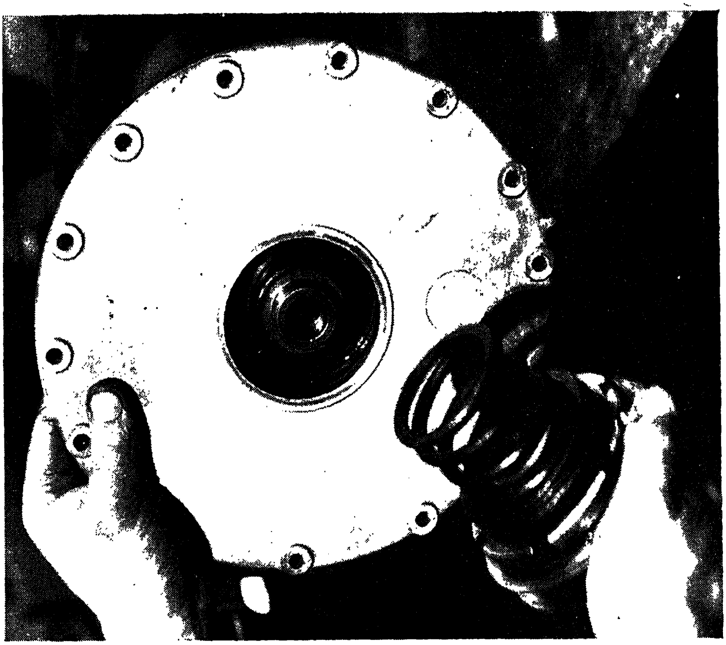


Fig. 7.—Adjustable Vibration Damper
Removing fan pulley, damper-adjusting nut, and spring.



Fig. 8.—Adjustable Vibration Damper
Removing front and centre damper plate.

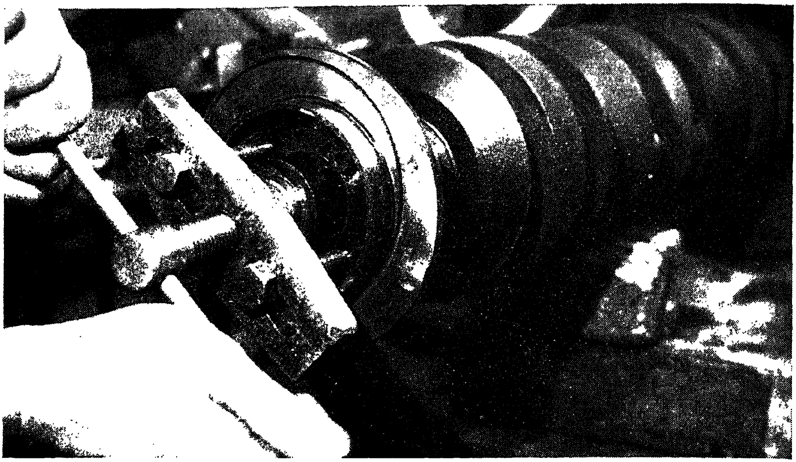


Fig. 9.—ADJUSTABLE VIBRATION DAMPER
Removing the fixed damper plate.

and water cannot enter, it is possible to experience trouble from this source after prolonged mileage. A particular point to watch is when the car is being washed with a high-pressure hose. Do not direct the hose on the damper, as water is likely to enter, which will cause rusting, and in time the damper will lose its efficiency.

" Metallastine " Damper

A new type of damper now being used is called the " Metallastine " damper. This type has no plates, but consists of a ring of moulded rubber in a casing.

Although very simple in design, the actual construction is complicated, as every damper is designed specially for each type of engine. The whole assembly is constructed in one piece and no dismantling or maintenance instructions are necessary.

Figs. 5–9 illustrate the adjustment and dismantling of an adjustable damper.

There are a number of other makes of vibration dampers, but as they are all designed on similar lines to the foregoing it is unnecessary to describe them, and, generally speaking, the instructions and notes mentioned will suffice for most types.

OVERDRIVE TRANSMISSION

OVERDRIVE transmission, when fitted to a car, is, in effect, an additional higher gear which comes automatically into operation at a certain speed, thus reducing engine speed with relation to car speed. When a Graham car, for example, is operated in the overdrive gear, the final drive ratio is approximately 3 : 1, which means a reduction in engine speed of about one-third. Because of the lower engine speed, overdrive operation is much quieter and smoother, economy in petrol and oil greater, and engine life increased.

Graham Overdrive Transmission

As an example of overdrive transmission, that on the Graham car is illustrated in Figs. 1–3. A later unit operates in exactly the same manner as the above type of overdrive, although the overdrive unit is somewhat different in its design and construction. The principal difference is in the shift assembly shown in Fig. 4.

Control

A control on the instrument panel is provided so that the driver may shift the overdrive in or out of operation.

With the manual control pulled all the way out, the overdrive unit is locked and will not operate. When the manual control is pushed in against the instrument panel, the overdrive will operate automatically at any car speed above 40 m.p.h.

Shifting into Overdrive

To make the shift into overdrive, it is necessary to accelerate to any car speed above 40 m.p.h.

After the car speed is above 40 m.p.h., the throttle must be closed momentarily to relieve the load from the overdrive. When this load is relieved, two pawls are thrown out by the centrifugal force and engage with the pinion carrier.

Shifting out of Overdrive

In order to shift from the overdrive back to the conventional top gear, all that is necessary is to close the throttle and allow the car speed to decrease below 40 m.p.h. The shift back to conventional is entirely automatic.

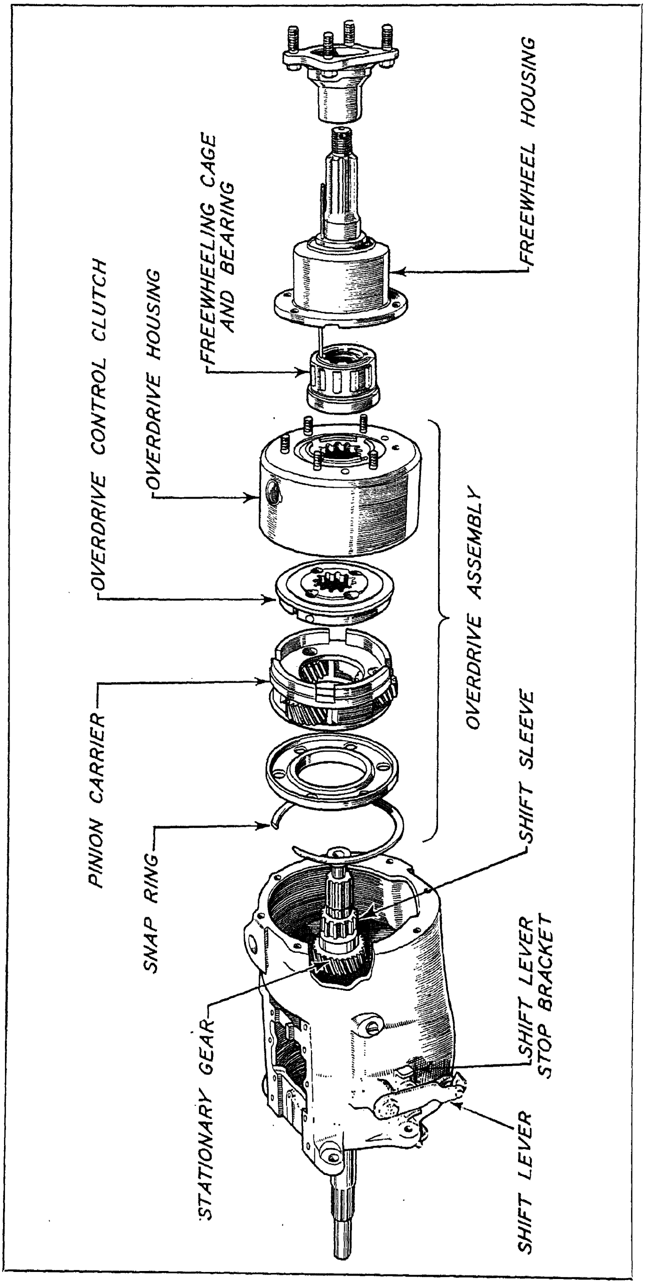


Fig. 1.—Graham Overdrive Assembly
Showing the order of assembly.

Free-wheeling

To ensure smooth shifting of the overdrive unit, a free-wheeling unit is incorporated with the overdrive. With the manual control on the instrument panel pushed in for overdriving operation, the free-wheeling unit operates. When the shift into overdrive is made, the free-wheeling unit is automatically locked out of operation.

Operating the Manual Control

The overdrive may be locked out by the manual control at any speed below 40 m.p.h. It cannot be locked out at speeds above 40 m.p.h. or after the shift into overdrive has been made.

To make the manual shift from overdrive to the lockout position it is necessary to have the engine driving the car. With the engine driving the car, depress the clutch pedal, at the same time pull the manual control out. Maintain the engine speed while the shift is being made.

To shift from the lockout to the overdrive position, depress the clutch and push the manual control in against the instrument panel.

The overdrive and free-wheeling units operate together and cannot be operated independently. The transmission must be operated as an overdrive with free-wheeling or as a conventional three-speed gear.

Lubrication

Lubrication of the overdrive transmission assembly is very important. It differs from a standard three-speed transmission because of the construction of the overdrive and free-wheeling unit.

It is necessary to use a high-quality oil, and for that reason regular transmission and axle oils are not recommended.

In winter it is recommended that a low cold-test engine oil (S.A.E. No. 50 grade) be used, and for hot weather an engine oil of a suitable grade (S.A.E. No. 70) must also be used.

Construction and Operation of Overdrive

Fig. 1 illustrates the Graham overdrive transmission unit disassembled in the exact order in which it is removed from the transmission.

It will be seen from this picture that the overdrive unit itself is assembled in a housing, and that the free-wheeling unit in a housing is bolted to the rear of the housing of the overdrive unit.

The overdrive unit itself is held in place by a snap ring.

The overdrive is accomplished through the small gears shown in the pinion carrier; these gears rotate around the gear which can be seen in the transmission housing, and also engage with internal teeth in the overdrive-unit housing, which transmits the power to the free-wheeling unit and thus to the propeller shaft.

Centrifugal force throws the pawls in the overdrive control clutch out so that they automatically engage in the slots in the pinion carrier.

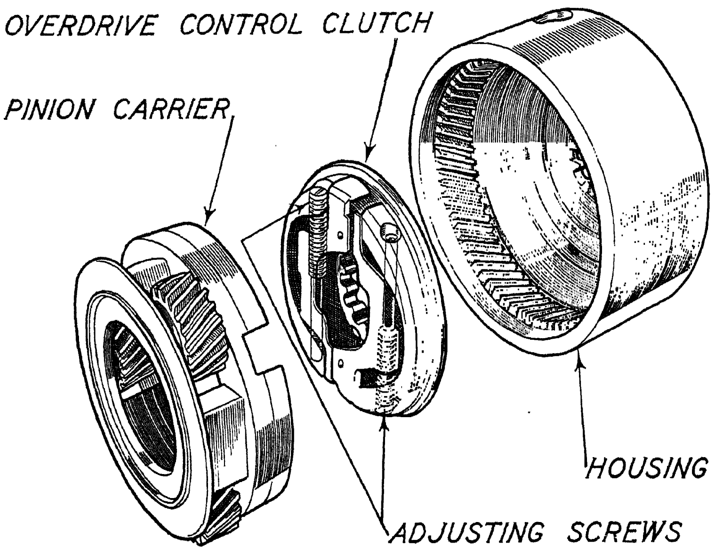


Fig. 2.—GRAHAM OVERDRIVE CLUTCH ASSEMBLY

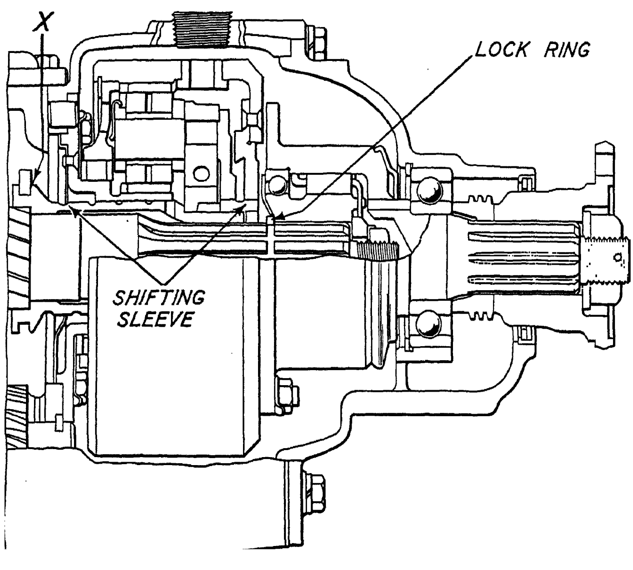


Fig. 3.—THE GRAHAM OVERDRIVE UNIT

To adjust manual shift, loosen lever stop (see Fig. 1), remove transmission cover, pry shift sleeve back against lock ring, move shift lever ahead until ·020 feeler can be inserted between shift fork and sleeve at point marked *x*, tighten lever stop and replace cover.

There should be little or no necessity for repairing the overdrive unit, and except for adjusting the engaging speed of the overdrive clutch, it is recommended that no repairs be made, but rather that the complete overdrive unit assembled in the housing be replaced as a unit together with the stationary gear. The free-wheeling unit can be replaced separately.

The free-wheeling unit consists of the free-wheeling clutch, a bearing, several rollers, and a cage inserted in a housing.

In order to assemble the free-wheeling unit, hold the clutch unit in one hand and turn the cage to the right to lock the rollers. A rod must be inserted in one of the small holes to lock the rollers in place. There is also a small hole in the housing into which the rod can be inserted and the unit assembled quite easily.

Cut-in Speed

The speed at which the overdrive unit will cut in can be changed by adjusting the overdrive clutch.

Before attempting to adjust the overdrive clutch, be sure that the dash control is operating correctly, so that when it is moved in either direction the lever on the side of the transmission will go against the stop on the case in both directions. This is very important, otherwise the shift may not take place at the same car speeds in every case, or in some cases may not take place at all. Unless the shifting sleeve is moved the full way in both directions when the manual shift is made, the pawls in the overdrive clutch will interfere on this sleeve and will not move freely. See instructions (Fig. 3) for sleeve setting.

Should adjustment be required on either type of overdrive transmission on Graham cars, it must be done in the following order :

To adjust Cut-in Speed

Drive the car until the transmission lubricant is warm ; jack up the rear of the car and remove the floor boards of the front compartment.

With the gear shift lever in neutral, line up the pawl slots in the clutch shell with the adjusting holes in the ring-gear housing and overdrive case by turning the propeller shaft continuously in one direction.

Put the gear shift lever in high gear and the dash control button in overdrive position.

Hold the clutch pedal down far enough so that the propeller shaft can be turned with just a slight drag from the clutch.

Have an assistant rock the propeller shaft back and forth in short strokes to rotate the overdrive clutch so that one of the adjusting-screw heads lines up with the holes in the housing (see Figs. 1 and 2).

By engaging the clutch, the overdrive clutch will be held from turning and the adjustment can be made.

The second screw is brought into position by repeating the operation

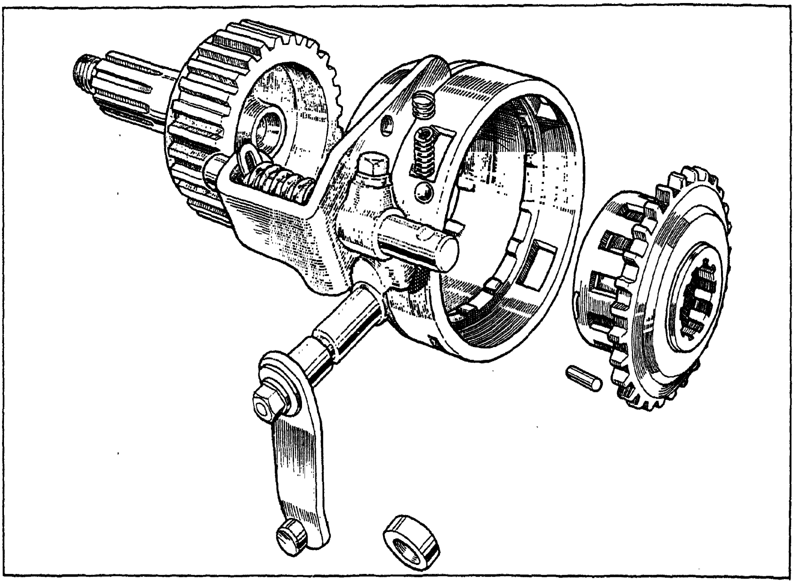


Fig. 4.—LATER TYPE OF GRAHAM MANUAL SHIFT ASSEMBLY

of disengaging the clutch partially and ratcheting the propeller shaft back and forth.

To make overdrive shift at a lower car speed, loosen adjusting screws (Fig. 2).

To make overdrive shift at higher car speeds, tighten adjusting screws.

Turn each screw exactly the same number of clicks. The adjustment should be limited to one or two turns in most cases. Be careful to see that screw heads do not extend above machined surface.

To adjust Manual Shift Sleeve Location

Remove floor board and gearbox cover.

Disconnect cable from the overdrive shift lever on side of gearbox. Loosen shift-lever stop bracket.

Force the shift sleeve back against the lock ring on the main shaft (Fig. 3). Rock the car back and forth while forcing the sleeve back. Be sure that it is against the lock ring.

Move the shift lever on the side of the transmission forward until a ·020 feeler can be inserted between the rear edge of the shift fork and the edge of the groove in the sleeve (see *x*, Fig. 3).

With the shift sleeve back against the lock ring and with the ·020 feeler in place, move the stop bracket against the shift lever and tighten it securely.

Pull the dash control out about $\frac{1}{8}$ in. and adjust the cable length so that it can be connected to the shift lever without moving either the cable or lever.

Replace the transmission cover and floor boards.

Packard Overdrive

Overdrive transmission on "Six," "Eight," and "Super-Eight" Packard cars is controlled through a knob on the instrument panel. When the knob is "out" the overdrive unit is locked out and the car operates in the conventional high gear.

With the control knob "in," the overdrive is engaged and cuts in automatically at any speed above 30 m.p.h. when the accelerator is released momentarily. It will remain in operation through all speeds above 20 m.p.h.; at speeds below this it becomes a free-wheeling unit.

To engage the overdrive, the control knob may be pushed in at any time or at any speed. But the car speed must reach 30 m.p.h., and the accelerator be released momentarily in order to have the overdrive become operative.

To disengage the overdrive, the car speed must be below 20 m.p.h. Then the engine speed must be brought up to the car speed and accelerated slightly while pulling out the control knob.

At speeds in excess of 20 m.p.h. the locking-out of the overdrive unit should not be attempted, and this prohibition applies equally when the car is decelerating. Failure to regard these instructions may wreck the unit.

For Quick Acceleration or Pulling

For quick acceleration or pulling, the overdrive can be put into third gear by depressing the accelerator right down to the floor. This operation automatically engages third speed and keeps it engaged as long as the accelerator is held down. The moment the pedal is released it automatically goes back into overdrive.

The above is effected by means of a solenoid on the side of the overdrive unit which disengages the unit and locks it out (Fig. 6). The solenoid is energised by a switch and relay mounted on the front of the dash. When the accelerator pedal is put all the way down, it closes the switch and through the relay operates the solenoid.

The accelerator linkage is arranged so that the carburettor throttle valve is fully open before the accelerator contacts the switch. This makes it possible to operate at full throttle without disengaging the overdrive. With the accelerator depressed so that the throttle is wide open, there should be 0·046-in. clearance between the accelerator lever and the switch. This clearance is adjusted by the adjusting screw in the lever (see Fig. 5).

In order that the locking device may engage and disengage without damage to the unit, the ignition is cut off momentarily with the tripping

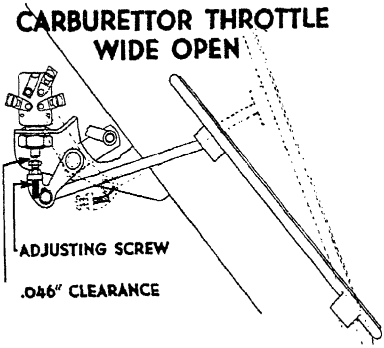


Fig. 5.—THE ACCELERATOR LINKAGE ON PACKARD CAR, SHOWING CARBURETTOR THROTTLE WIDE OPEN

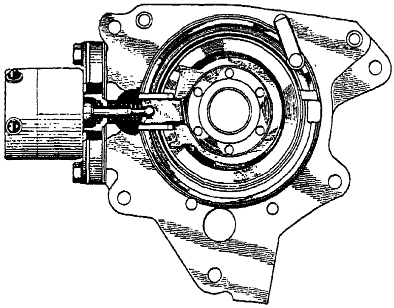


Fig. 6.—SOLENOID ON SIDE OF OVERDRIVE UNIT FOR DISENGAGING UNIT AND LOCKING IT OUT

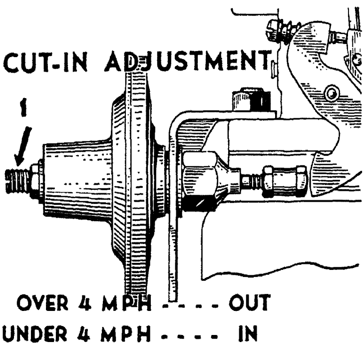


Fig. 7.—CUT-IN ADJUSTMENT OF THROTTLE GUARD FITTED TO CARBURETTOR

1 is the screw for adjusting diaphragm spring pressure.

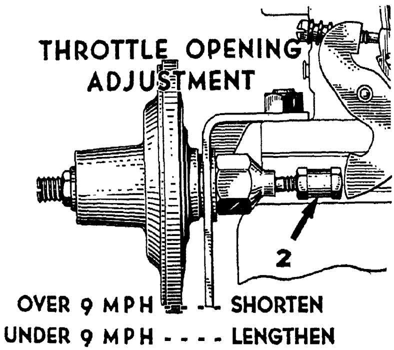


Fig. 8.—THROTTLE OPENING ADJUSTMENT

2 is the adjusting knob for controlling length of throttle guard plunger.

of the accelerator pedal switch. Particular attention must be paid to the installation of the solenoid unit when this is changed. The electrical connections must face the rear of the car, and the same solenoid gasket or one of exactly the same thickness must be replaced.

To prevent Engine Stalling when Free-wheeling

As a precaution against the possibility of the engine stalling when free-wheeling, a throttle guard is fitted to the carburettor. When idling, if engine speed and manifold vacuum fall off, a vacuum-controlled plunger works against a finger on the carburettor throttle lever and opens the throttle momentarily to increase the engine speed to prevent stalling. There are two adjustments (Figs. 7 and 8). First, there is a screw in the diaphragm housing which regulates the tension of the diaphragm spring,

and the car speed at which the throttle guard comes into operation; second, an adjustable knob on the end of the plunger regulates the amount the throttle is opened by the throttle guard.

Cutting-in of the throttle guard above a speed of 4 m.p.h. indicates too much diaphragm-spring pressure, and it should be decreased by turning the adjusting screw "out." Should it engage at less than 4 m.p.h., or even fail to operate, then there is too little spring pressure and the screw must be turned "in."

The amount of throttle opening with the throttle guard in operation is controlled by the length of the plunger. If it produces a car speed in excess of 9 m.p.h., it should be decreased by turning the adjusting knob on the plunger in toward the diaphragm to decrease the amount of throttle opening. If less than 9 m.p.h., increase the length of the plunger by turning the adjusting knob out toward the throttle lever.

CHEVROLET ENGINE AND CLUTCH

ENGINE

Pistons

THE pistons are cast iron, electro-plated, with a slipper skirt with three ring grooves located above the gudgeon-pin holes. The pistons are cam ground out of round, to compensate for heat expansion along the line of the gudgeon-pin bosses.

The lower ring is of the oil-control type.

If it is necessary to replace pistons, due to wear, the cylinder walls should be honed for ·003-in. oversize or rebored and honed for ·010-in., ·020-in., ·030-in., and ·040-in. oversize pistons.

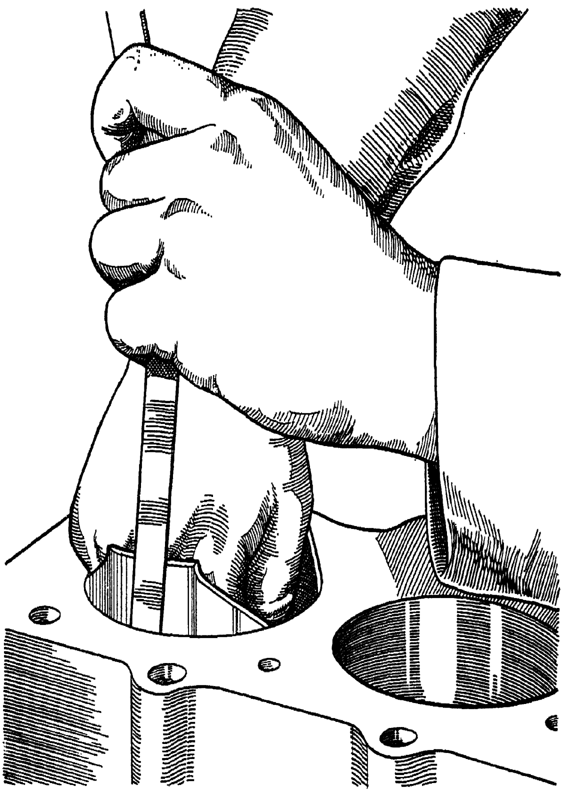


Fig. 1.—Fitting pistons

The correct fit is when the piston can be pushed down the cylinder on a ·002-in. feeler, using a light pressure, and be locked on a ·003-in. feeler. Note that feeler gauge must be at right angles to gudgeon pin.

Fitting Pistons

After the cylinder bores have been rebored within ·002 in. of the size desired, they should be finished or polished with a hone.

Use an expanding-type hone, with the blades or stones expanding when the nut on the top of the hone is turned.

In operation, the hone is placed into the cylinder bore and expanded until it can just be turned by hand. The hone is then operated, up and down, in the

bore until it begins to run free. Then the expanding-nut, on the top of the hone, is tightened and the hone passed, up and down, in the bore until it runs free. This same procedure should be followed until the piston you are fitting can be pushed through the cylinder on a ·002-in. feeler, using a light pressure, and be locked on a ·003-in. feeler. The feeler gauge must be at right angles to the gudgeon pin (*see* Fig. 1).

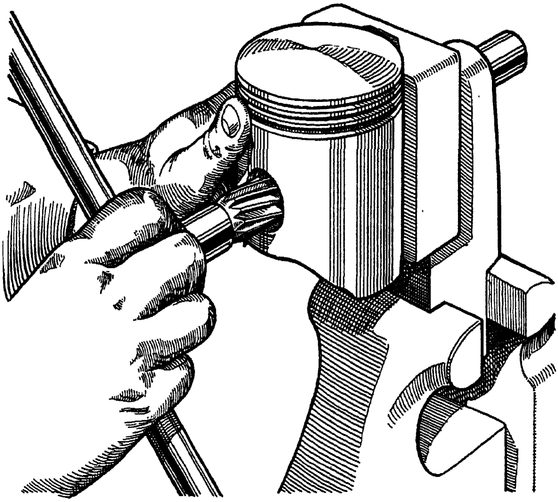


Fig. 2.—PISTON-PIN BUSHING REAMER

Do not exert heavy pressure on the piston when pushing it into the cylinder bore to check fit with a feeler gauge.

Fitting Gudgeon Pins

The pistons are supplied with the gudgeon-pins and bushes fitted in them. Should it be found necessary to replace the pins, due to the bushing becoming excessively worn, the following procedure should be carefully followed :

(1) Place the gudgeon-pin-bushing reaming fixture in a bench vice.

(2) Adjust the expansion reamer for a light cut.

(3) Insert the reamer in the bushing and start the reamer pilot into the guide in the fixture.

(4) Hold the piston in the V-block of the fixture with one hand and turn the reamer handle with the other hand until the reamer has passed through both bushings, as shown in Fig. 2.

(5) Expand the reamer by easy stages and repeat the reaming operation until the gudgeon pin is fitted. The proper fit of the gudgeon-pin is a "thumb push" fit, as shown in Fig. 3.

After fitting the first gudgeon pin, the other bushings may be reamed quickly by reducing the diameter of the reamer by approximately ·0005 in. (half a thousandth) by backing off the expansion screw. This permits quick roughing-out of all bushings, leaving about half a thousandth for the finish cut.

It is good practice to check the diameter of all gudgeon pins with a

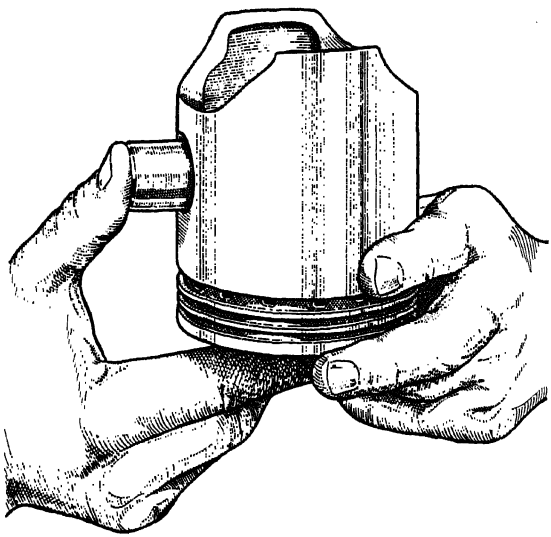


Fig. 3.—FITTING GUDGEON PIN

The proper fit for gudgeon pin is a thumb-push fit.

micrometer, in case there should be a slight variation in diameter. Should a variation exist, this must be taken into consideration when adjusting the reamer for the finish cut.

The purpose of the reaming fixture is to make sure that the gudgeon-pin bushings will be reamed at right angles to the skirt of the piston, assuring proper alignment of the piston in the cylinder.

Piston Rings

The compression ring used in the 1938 engine is designed to control oil consumption during the running-in period. The face of the ring is tapered one-thousandth of an inch. With this design the lower edge of the ring tends to scrape the excess oil from the cylinder wall and acts as an oil-control ring until the regular oil-control ring is seated (run-in) in the cylinder. All compression rings are marked with the word " TOP " cast in the upper side of the ring. When installing 1938 compression rings, make sure the marked side (" TOP ") is towards the top of the piston.

Fitting Piston Rings

The gap between the ends of the ring when tried in the bore should be from ·004 in. to ·014 in.

Slip the back side of the ring into its groove, and roll it entirely around the groove, to make sure that the ring is free and does not bind in the groove at any point.

At the top ring a ·002-in. feeler should be very free, but a ·003 in. should cause a rather heavy drag. At the centre ring, the ·002-in feeler should be just free and the use of a ·003 in. feeler should cause the ring to lock in the groove. At the bottom, or oil-control groove, the ·002-in. feeler should produce a light drag.

The rings should be selectively fitted to each individual bore and each ring groove of the piston. A final test of the ring fit in the groove is to

repeat the fitting procedure given above, after the rings are assembled in the grooves of the pistons.

When it is necessary to replace main bearings, the transmission pilot hole in the clutch housing may be used in the alignment of a boring bar.

After threading the boring bar

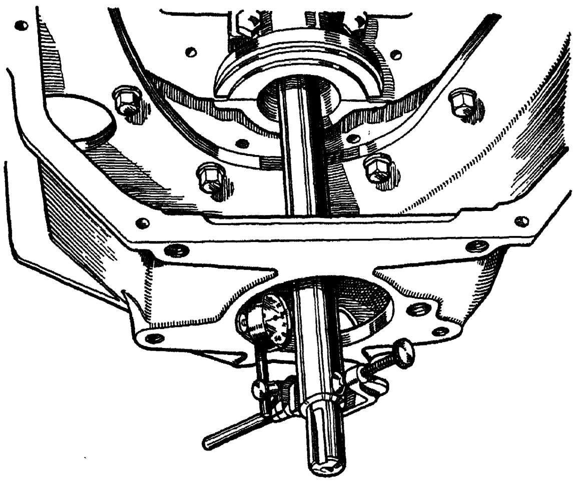


Fig. 4.—CHECKING CLUTCH HOUSING WHEN USING MAIN BEARING BORING BAR

through the bushings from the rear to the front, mount a dial gauge and check the alignment of the transmission pilot hole in the clutch housing (Fig. 4). The run-out must not exceed ·015 in. If it does, it will be necessary to replace the clutch housing before proceeding with the job.

The front and front intermediate bearing shells are very similar in appearance, and it is possible to get them mixed. The front intermediate shells

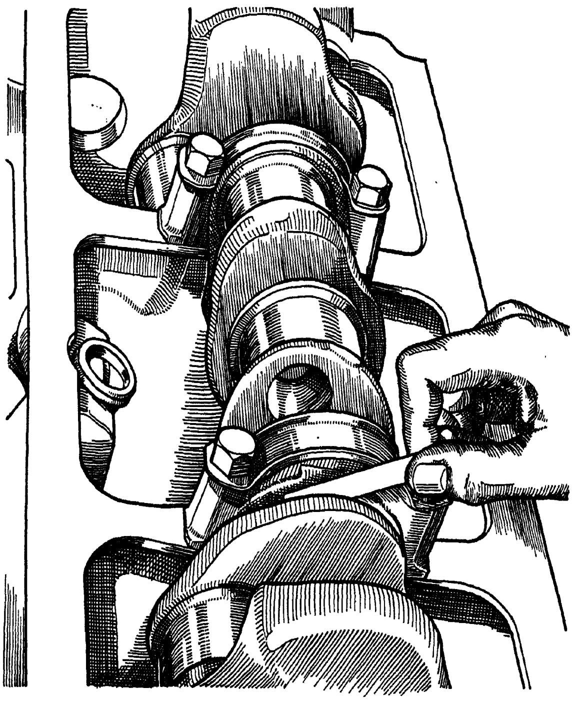


Fig. 5.—CHECKING CRANKSHAFT END PLAY
This clearance should be from ·004 in. to ·007 in.

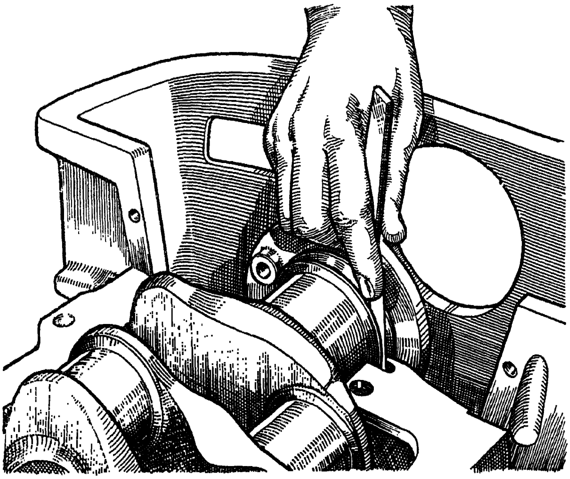


Fig. 6.—CHECKING CRANKSHAFT OIL SLINGER CLEARANCE
The clearance should be from ·002 in. to ·032 in.

are identified by the letter "I" in the bottom of the oil groove. Should the intermediate-bearing shell be installed in the front-bearing bore, the sides of the bearing would be too high and would not permit the cap to seat firmly on the shims.

The rear intermediate main bearing carries the crankshaft end thrust and also forms the correct location of the crankshaft oil deflector at the rear of the crankshaft. Therefore it becomes absolutely necessary, when replacing main bearings, to use an accurate tool to face the flanges of the rear intermediate bearing

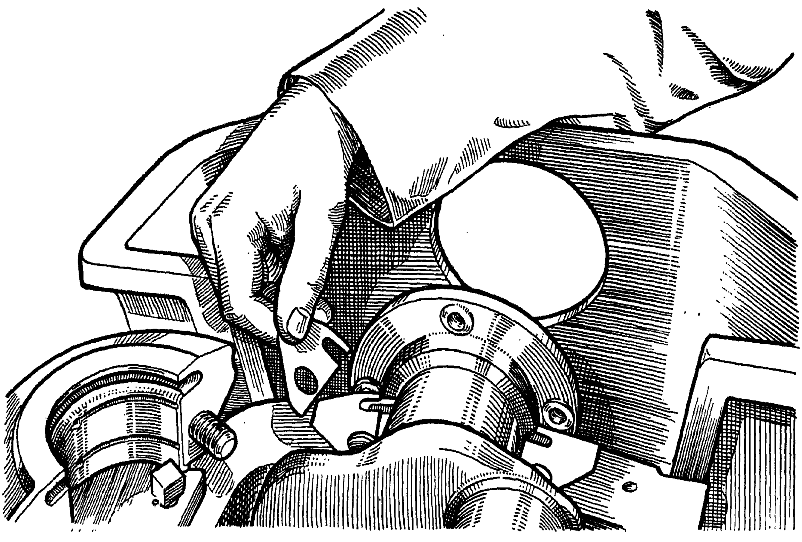


Fig. 7.—ADJUSTING MAIN BEARINGS
Removing rear main bearing shim.

to the correct width, so that the crankshaft will have the correct end clearance of ·004 in. to ·007 in.

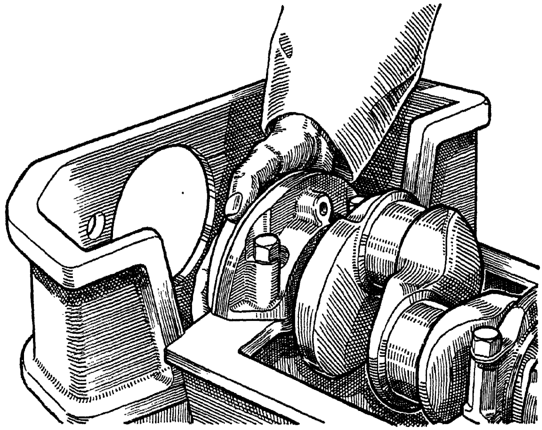


Fig. 8.—CHECKING FIT OF MAIN BEARINGS AFTER ADJUSTMENT

If the shaft turns freely by hand, after all bolts have been tightened, the bearings are properly adjusted.

Crankshaft

The following is a list of the sizes of the main-bearing and connecting-rod journals of the crankshaft: front, 2·6855–2·6865 in.; front intermediate, 2·7165–2·7175 in.; rear intermediate, 2·7475 in.–2·7485 in.; rear, 2·7785–2·7795 in.; connecting-rod journal, 2·311–2·312 in.

Installing Crankshaft

Blow out all cutting from the bearings.

Clean out all oil passages by blowing them out with compressed air. It is a good practice to blow out each oil passage separately—this can be done by placing the fingers on the oil hole in three of the bearings while the nozzle of the air-gun is placed in the oil inlet of the cylinder block. After blowing out the oil passages of all four bearings, then blow through each of the oil passages from the main bearings to the camshaft bearings.

Check the end play by forcing the crankshaft to its extreme rear position. Check at the rear side of the rear intermediate bearing with a feeler gauge (*see* Fig. 5). This clearance should be from ·004 in. to ·007 in. Experience has shown that clearance up to ·011 in. at this point will not cause noise. Original close fitting means long life.

With the crankshaft still in its extreme rear position, check the clearance between the oil deflector on the crankshaft, and the edge of the oil groove in the cylinder block, just back at the rear main bearing. Check should be made with a feeler gauge between the above-mentioned places. This clearance should be from ·002 in. to ·032 in. (*see* Fig. 6). This dimension is obtained by the amount of stock that is removed from the front face of the rear intermediate main bearing.

Install the bearing caps with four ·002-in. shims on each side and pull the bolts down snugly. Check to see the crankshaft rolls freely.

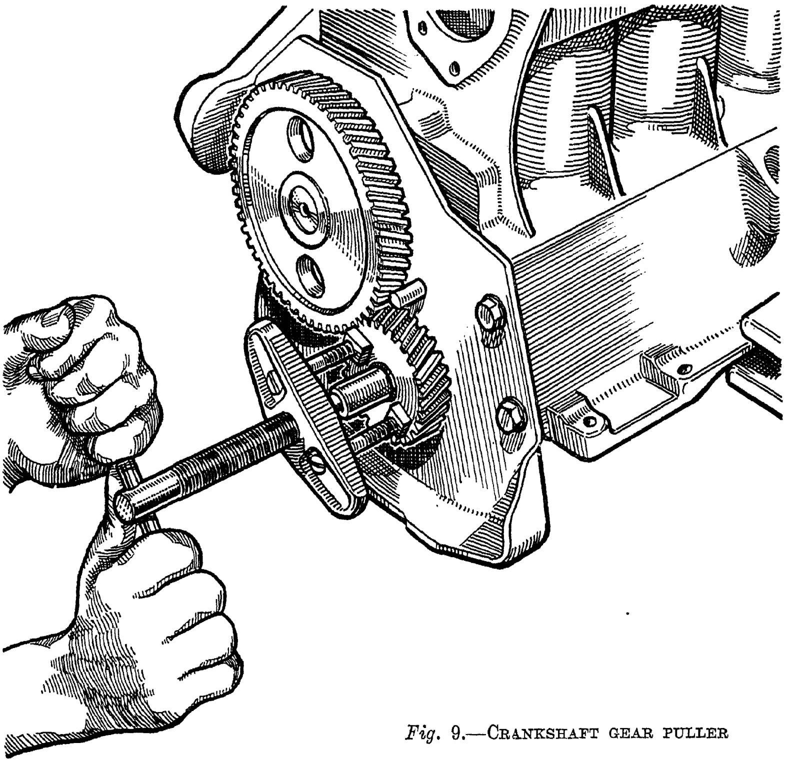


Fig. 9.—CRANKSHAFT GEAR PULLER

Adjusting Main Bearings

Starting with the rear bearing, remove shims (Fig. 7) evenly until there is a slight drag on the crankshaft (turning it by hand) with the bolts pulled down tight. Then replace one ·002-in. shim for clearance, again tighten the bolts, and check for drag. The crankshaft should now roll freely without any indication of a drag.

Loosen the bolts on the bearing that has just been adjusted and proceed to adjust the next one in the same manner, and so on until all bearings have been adjusted.

When adjusting the bearings, shims should be removed evenly. If an uneven number of shims has to be used, it is good practice to have the greater number of shims on the same side of all bearings.

If the shaft turns freely by hand, after all bolts have been tightened, you know the bearings are properly adjusted (Fig. 8).

The Timing Gears

The gear on the end of the crankshaft, or the crankshaft timing gear, is cut from a solid piece of steel. It is a drive-fit on the end of the crankshaft, as well as being held in place with a key.

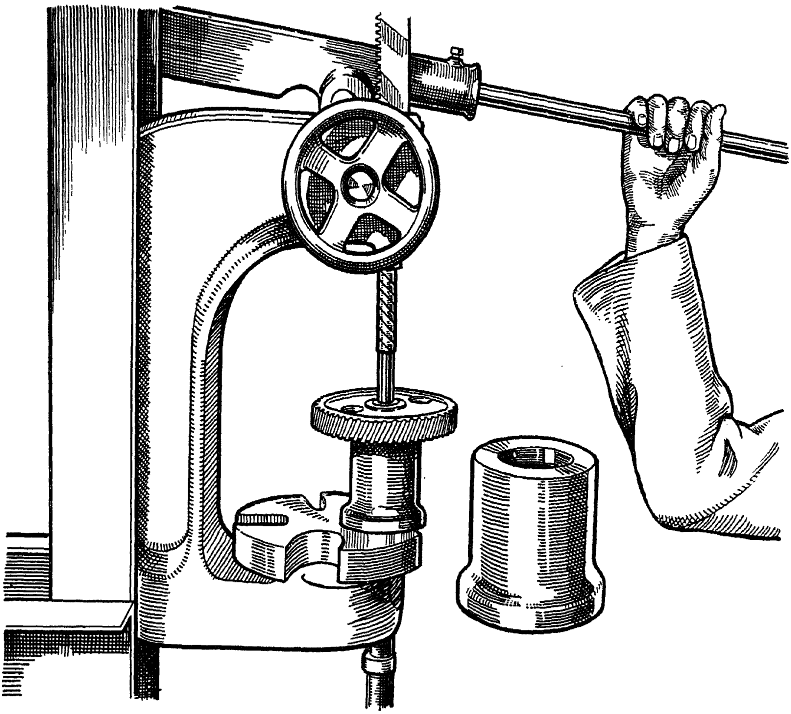


Fig. 10.—CAMSHAFT GEAR-REMOVING SLEEVE

To properly remove this gear, without damage to it, a gear puller, such as is shown in Fig. 9, is necessary. To replace this gear a driver is essential, so that the gear can be driven straight back on its seat accurately.

The camshaft timing gear is a bakelite and fabric gear.

If it becomes necessary to replace the camshaft gear, a sleeve to properly support the gear on its hub is necessary. This sleeve, shown in Fig. 10, removes the gear, but it so damages the thrust-plate that it is very important that every time a gear is removed from the camshaft, a new thrust-plate must be used.

In replacing the gear on the camshaft, the back of the front journal of the camshaft must be firmly supported in an arbor press and the camshaft thrustplate assembled to the camshaft, after which the gear is pressed on the shaft far enough so that the camshaft thrust-plate has no clearance, yet is free to revolve. The correct clearance is—a free fit to a maximum of ·003 in. It is very important that the gear be pressed on the camshaft, using the hub of the gear as a pressing medium, and not the outside of the gear. Serious damage will be done to the gear if it is pressed on the shaft using the outside of the gear.

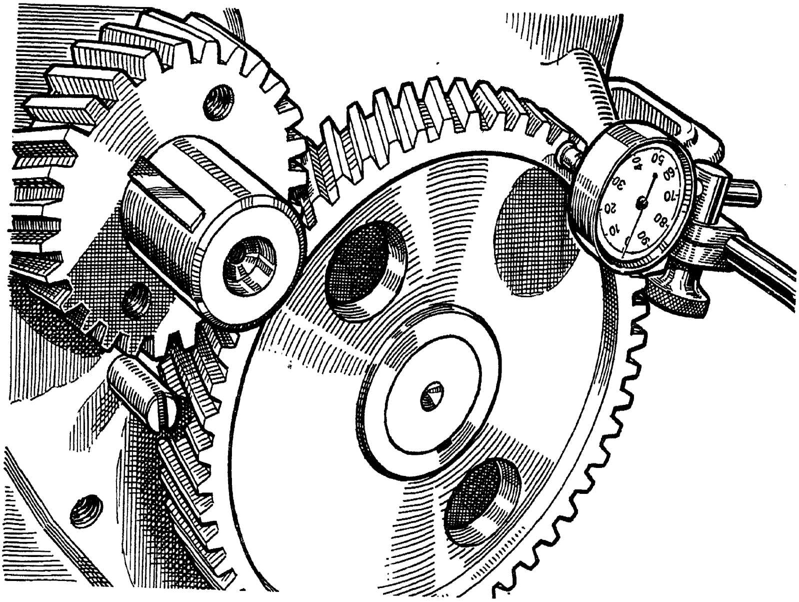


Fig. 10A.—CHECKING RUN-OUT OF TIMING GEARS WITH DIAL INDICATOR

The crankshaft timing gear run-out should not exceed ·003 in., while camshaft gear run-out should not exceed ·004 in.

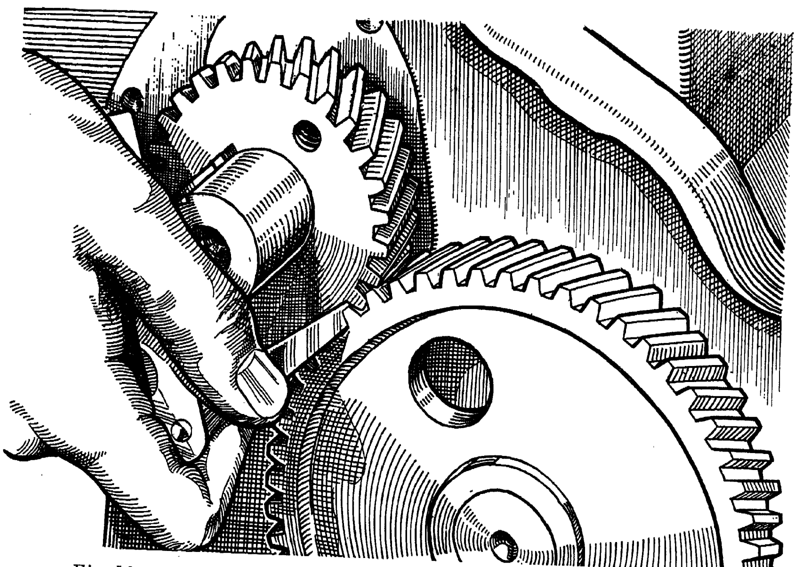


Fig. 10B.—TIMING GEAR BACKLASH SHOULD BE FROM ·002 TO ·005 IN.

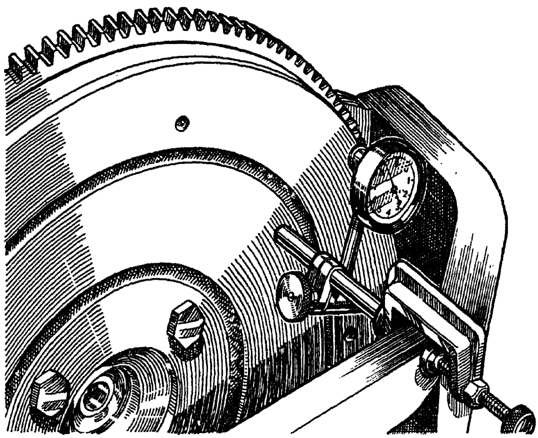


Fig. 11.—CHECKING FLYWHEEL RUN-OUT

The thrust bearing, on the inside of the camshaft gear, when it is assembled to the camshaft, determines the amount of camshaft end play.

If there is an excessive amount of end play in the camshaft, it is necessary to remove the gear and shaft assembly and press the gear farther on the shaft so that the thrust-plate is tight, yet free to revolve, to a maximum of ·003-in. clearance.

When the camshaft and gear are assembled to the engine, it is important that the punch-marks on both the camshaft and the crankshaft gears be opposite each other.

The camshaft will then be in its proper position so that the valves will open and close in the proper relation to the movement on the piston.

After the camshaft and crankshaft gears are in their proper places, check the crankshaft timing gear for run-out with a dial indicator. This should not exceed ·003 in. Then check the run-out of the camshaft gear. This should not exceed ·004 in.

If these run-outs are excessive, remove gears, to be sure that burrs on the shaft or gears are not causing run-out. If necessary, replace with new gears. The backlash should be checked. This check is made with a feeler gauge placed between the teeth of the gears. This should be from ·002 in. to ·005 in.

Flywheel

After the flywheel has been assembled to the crankshaft, it is necessary that the face and the rim of the flywheel be checked for run-out. This can be done with the dial indicator, as shown in Fig. 11. The face and rim of the flywheel should not exceed ·008 in. run-out.

When fitting Connecting Rod

It is absolutely essential to see that the piston is square with the bearings of the big end. This can readily be checked by the standard type of piston aligner.

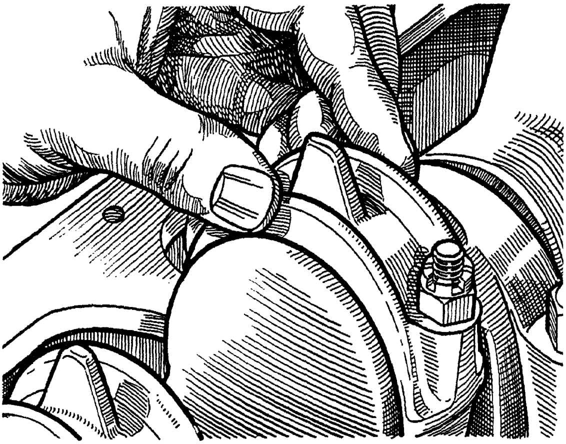


Fig. 12.—CHECKING CONNECTING-ROD BEARING FIT

When the bearing is correctly fitted, it should be possible to snap the rod back and forth on the crank pin with one hand.

Adjusting Connecting-rod Bearings

Remove shims, an equal number from each side of the bearing, until the rod cannot be snapped back and forth on the crankpin by hand, but can be tapped back and forth with a light blow of an 8-oz. hammer. Then replace one ·002-in. shim, being careful to keep the number of shims on each side equal, if possible. When the bearing is properly fitted, it should be possible to snap the rod back and forth on the crankpin with one hand (Fig. 12).

If it is not possible to keep the number of shims on each side equal for all bearings, it is preferable to have the greater number of shims on the camshaft side.

Check connecting-rod end clearance, using a feeler gauge. This should be from ·004 in. to ·011 in. (Fig. 13).

As a final and last check to be sure that the assembly will travel true with the bore, check the clearance between the gudgeon-pin end of the connecting rod and the gudgeon-pin bosses on the piston with a feeler gauge. This should not be less than ·025 in.

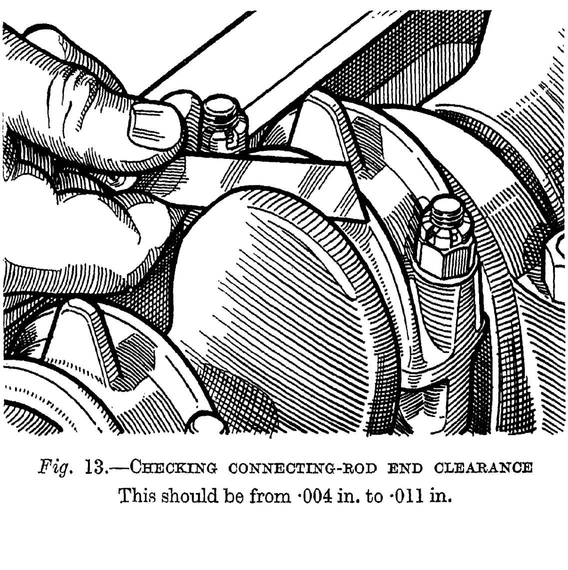


Fig. 13.—CHECKING CONNECTING-ROD END CLEARANCE

This should be from ·004 in. to ·011 in.

Connecting-rod Dippers

The height of the connecting-rod dippers is very im-

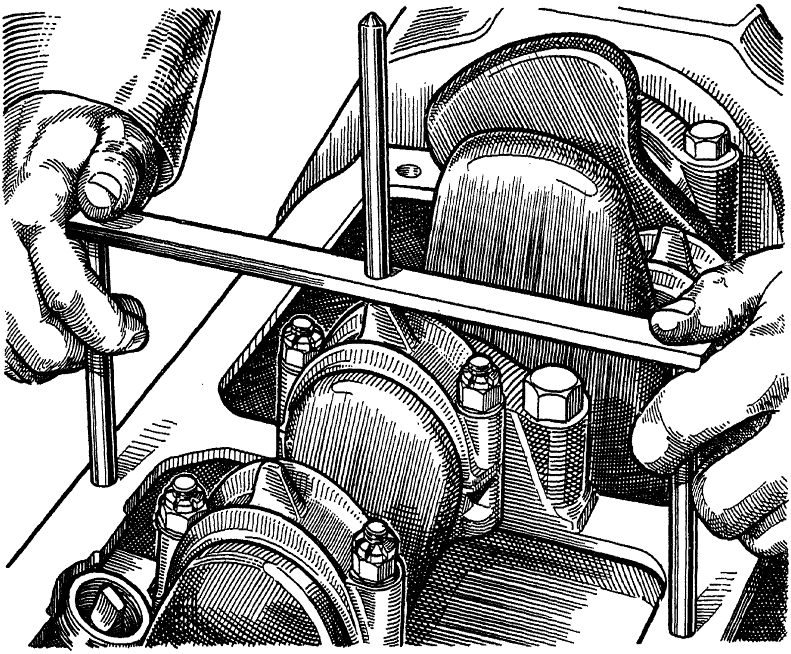


Fig. 14.—CONNECTING-ROD DIPPER HEIGHT
The centre pin of the gauge is used to check oil trough depth in the oil-pan.

portant, to ensure proper lubrication of connecting-rod bearings.

The oil-trough depth and connecting-rod-dipper height gauge is used to check the height of the dipper from the machined surface of the crankcase. With the two side pins of the gauge resting on the crankcase flange (Fig. 14), the end of the dipper should just touch the bottom of the crossbar on the gauge.

If the dipper is lower than the gauge, a new dipper must be installed.

If the dipper is higher than the gauge, it may be bent down to the correct position.

Note.—The oil-pan gasket must be removed during this operation.

Another tool is required to check the oil-nozzle height in each oil trough. (The nozzles eject oil on to the dippers, forcing the oil into the connecting-rod bearings.)

Valve Clearance

Inlet-valve clearance should be a minimum of ·006 in. to a maximum of ·008 in. hot.

Exhaust-valve clearance should be a minimum of ·013 in. to a maximum of ·015 in. hot.

Engine Mountings

Cushion balanced engine mountings are used to prevent even the smallest amount of engine vibration from being transmitted to the passengers.

To adjust these mountings proceed as follows :

(1) Tighten the front engine-mounting bolts. Should the mountings be oil soaked it will be necessary to replace them.

(2) Tighten the rear engine-mounting bolts (at the rear of the transmission). Make sure mounting studs are tight in transmission case.

(3) Check the clearance between the transmission cross-member and the U-section plate. This clearance should be from ·005 in. to ·015 in. If the clearance exceeds these limits, remove the mounting and bend the U-section plate until the clearance is within the above limits.

Note.—This clearance is very important, because it limits the fore-and-aft movement of the engine.

(4) Tighten the side engine-mounting bracket bolts.

(5) Remove the bolts from the engine side mountings and check the clearance between the mounting and its bracket on each side ; if the clearance is more than $\frac{1}{16}$-in., shim with $\frac{3}{8}$-in. plain flat washer. If the clearance is less than $\frac{1}{16}$-in., loosen the bracket bolts and push the mounting upward. (There may be sufficient clearance in the bracket-bolt holes to give the necessary $\frac{1}{16}$-in. clearance.). If you are unable to get the proper clearance in the manner mentioned above, remove the brackets and elongate the holes with a round file until you have $\frac{1}{16}$-in. clearance between the mounting and bracket.

It is important that these mountings be set up with an equal amount of tension on each side.

Compression

At normal operating temperature the minimum compression is 90 lb., and each cylinder should balance within 5 to 10 lb.

Sparking Plugs and Contact Points

Type AC-46 with ·040-in. gap is the proper sparking plug for 1938 Chevrolet engines. Contact-breaker points should be set at ·018 in.

CLUTCH

Operation

A new type of clutch is used in 1938 Chevrolet cars. This is of the single-plate dry-disc type and is designed around a diaphragm spring which has the shape of a dished washer with eighteen tapering fingers pointing inward. The action of the diaphragm spring may be compared to the flexing action of the bottom of an ordinary oil-can. By depressing the clutch pedal, the throw-out bearing is forced against the diaphragm-spring fingers, causing the diaphragm spring to pivot on the pivot rings (Fig. 15).

When the clutch is engaged, the action is as shown in Fig. 16. When the clutch pedal is depressed, pressure of the throw-out bearing on the inner ends of the fingers causes a diaphragm action, and the outer ends of the fingers, near the rim, pivot on the inner pivot ring (Fig. 17). This action causes the rim of the spring and the pressure-plate to move away from the clutch disc, disengaging the clutch. When the clutch pedal is released and the throw-out bearing no longer contacts the fingers, the "spring" in this material causes the fingers to pivot about the near pivot ring and the rim to bear against the pressure-plate.

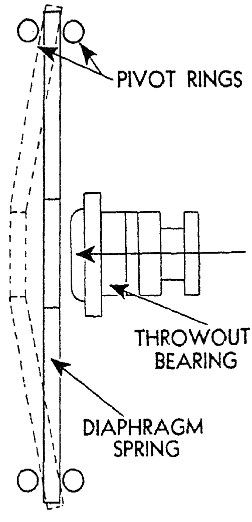


Fig. 15.—ACTION OF DIAPHRAGM SPRING

Clutch Noises

A rattling noise in the clutch assembly at idling speed when released may sometimes be caused by insufficient tension of the retracting springs. This noise can be easily remedied by replacing the retracting springs.

(1) Remove the clutch housing underpan.

(2) Hand-crank the engine until one retracting-spring retaining bolt is at the bottom. Remove the bolt and retracting spring and install a new spring.

(3) Replace the other two retracting springs in the same manner as described above.

If the above does not correct the rattle, the clearance between the drive lugs on the pressure-plate and the slots in the clutch cover should be checked. If this clearance exceeds ·010 in., the pressure-plate or cover should be replaced, or both if necessary, to obtain proper clearance.

A rattle in the clutch throw-out fork may be caused by the fulcrum ball being loose in the fork. On 1938 models, the throw-out fork may be removed as follows, without removing the transmission :

(1) Remove the flywheel underpan.

(2) Disconnect the clutch fork from the clutch pedal.

(3) With $\frac{7}{8}$-in. and $\frac{3}{4}$-in. wrenches, remove the throw-out-fork mounting and remove the fork.

(4) Remove the ball-retainer spring, ball retainer, and ball.

(5) Pack the ball seat in the fork with high-melting-point grease, and install a new ball if it is scored or worn, ball retainer, and retainer spring.

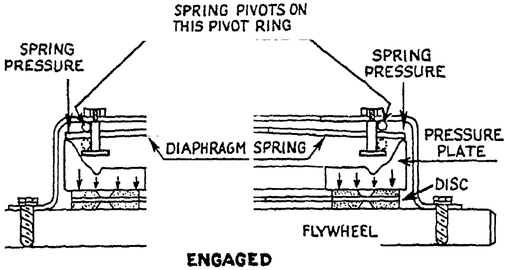


Fig. 16.—CLUTCH—ENGAGED POSITION

Note.—When re-assembling, be sure to place the upturned ends of the ball-seat retainer spring *down* in the opening of the ball retainer. If installed with the ends up, the retainer spring cannot seat in the machined groove in the throw-out fork.

(6) Replace the fork and adjust the clutch pedal for $\frac{3}{4}$-in. to 1-in. free travel before the throw-out bearing contacts the clutch fingers.

Care

The dry-disc-type clutch requires very little care during its life. There is only one simple adjustment necessary to maintain clutch efficiency and assure long life. This adjustment is for the amount of free clutch-pedal travel before the throw-out bearing contacts the clutch fingers.

The new ball throw-out bearing, in conjunction with the new clutch spring, makes a more simple construction and results in less friction and wear in the mechanism. The new bearing is of the sealed type, and is packed with a high-melting-point lubricant which makes further lubrication unnecessary, except for packing the inner and outer grooves of the throw-out bearing collar when assembling.

Checks to be made before overhauling Clutch

There are quite a number of things that will affect clutch operation besides the clutch. For this reason there are certain preliminary inspections that must be made in order to determine whether or not the trouble lies with the clutch. These inspections are as follows :

(1) Check the clutch adjustment and make sure that the pedal has from $\frac{3}{4}$ to 1 in. of free travel before the clutch starts to disengage.

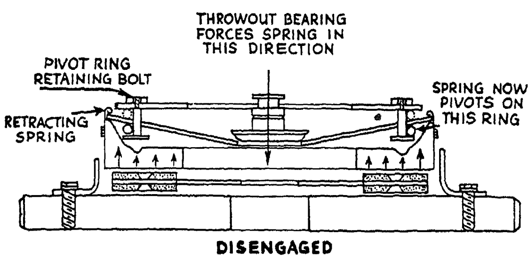


Fig. 17.—CLUTCH—DISENGAGED POSITION

(2) Check the clutch-pedal bushing for wear and for sticking on the shaft or striking the floor-board.

Lubricate the pedal linkage.

(3) Tighten the front engine-mounting bolts (both top and

bottom bolts). Should the mountings be oil-soaked it will be necessary to replace them.

(4) Tighten the rear engine-mounting bolts (at the rear of the transmission). Make sure mounting studs are tight in transmission case.

(5) Check clearance between the transmission cross-member and the U-section plate. This clearance should be from ·005 in. to ·015 in. If the clearance exceeds these limits, remove the mounting and bend the U-section plate until the clearance is within the above limits.

This clearance is very important, because it limits the fore-and-aft movement of the engine.

(6) Tighten the side engine-mounting bolts.

(7) Remove the bolts from the engine side mountings and check the clearance between the mounting and its bracket on each side; if the clearance is more than $\frac{1}{16}$ in. shim with $\frac{3}{8}$-in. plain flat washer. If the clearance is less than $\frac{1}{16}$ in., loosen the bracket bolts and push the mounting upward. (There may be sufficient clearance in the bracket-bolt holes to give the necessary $\frac{1}{16}$-in. clearance.) If you are unable to get the proper clearance in the manner mentioned above, remove the brackets and elongate the holes with a round file until you have $\frac{1}{16}$-in. clearance between the mounting and bracket.

It is important that these mountings be set up with an equal amount of tension on each side.

Inspection

The first step in connection with inspection of the clutch is to wash all parts (except the throwout bearing) in *clean* petrol.

The clutch ball throwout bearing is permanently packed with lubricant and should not be soaked in petrol, as this may dissolve the lubricant from around the bearing balls.

(1) Inspect the pressure plate and flywheel for any indication of scores on the contact surface. Then check the three drive lugs for burrs and make sure that these lugs move freely in the three slots in the cover. Check the clearance between the lugs and the cover; this clearance should be from ·004 in. to ·010 in.

(2) Inspect the diaphragm spring and the pivot rings for any indication of cracks or distortion.

(3) Check the throwout bearing for roughness and free fit on the extension of the transmission main drive gear bearing retainer.

(4) Check the run-out of the transmission pilot hole in the clutch housing. This should be within ·008 in. indicator reading.

(5) Check fit of the ball in the throwout fork; this should be snug without end play.

(6) Inspect the clutch disc for worn, loose, or oil-soaked facings, broken springs or rivets loose on hub. Examine the splines and check to see that

they move freely on the splines of the transmission clutch gear. If the splines are worn, the clutch disc should be replaced.

Clutch Facings

The facings must be removed from the clutch disc by drilling from the head or smooth side of the rivet. Drilling from the other side will spin the rivet. Never remove these rivets on a brake relining machine, as it will spring or distort the clutch disc.

In riveting new facings to the clutch disc, the rivet should be flattened the proper amount, i.e. $\frac{7}{32}$ in. It is advisable to obtain Chevrolet rivets, designed and made especially for this part. In assembling the rivets, they must be reversed two each way.

Clutch Pilot Bearing

The clutch pilot bearing is a special oil shield type ball bearing. This bearing needs attention only when the clutch is removed from the car, at which time it should be removed, cleaned, and inspected. Replace if necessary. Before installing bearing, it should be packed with a very small amount of special high temperature grease.

Take care when removing this bearing not to damage it. When refitting, press into place in exact alignment with the transmission pilot hole in the flywheel housing.

Before installing the ball throwout bearing assembly to the clutch throwout fork, pack the recess on the inside of the throwout bearing collar, and coat the throwout fork groove with a high melting-point lubricant.

We are indebted to General Motors Ltd. for the information upon which the above article is based.

DENNIS 35-, 40-, 50-, AND 60-CWT. GOODS-CARRYING VEHICLE

THE ENGINE, CLUTCH, AND GEARBOX

By S. E. SMITH

ENGINE

THE engine unit employed in the whole range of Dennis lightweight goods-carrying vehicles is identical, with the only exception that the most later models have certain modifications incorporated in the design to give improved performance.

The engine is a four-cylinder unit, with cylinders and crankcase cast as one unit. The cylinder head is detachable. All the auxiliaries are situated on the near side of the engine, with the exception of the starter motor. The standard equipment provides for coil ignition and Zenith carburettor type 36 V.E.1. The main details of the engine are as follows :

Bore and stroke	100 mm. by 120 mm.
R.A.C. Rating	24·8 h.p.
Maximum b.h.p.	60 h.p.
B.h.p. at 1000 r.p.m. . . .	30 h.p.
Firing order	1, 3, 4, 2.

Dismantling Engine for Overhaul

After having removed the engine from the chassis, the work of dismantling should be commenced by first of all removing all the accessories ; namely, the carburettor and controls, distributor, and the fan and water pump. Next take off the exhaust and inlet manifolds, valve cover plates, fuel pump, and oil filter (which is secured by studs and nuts to the side of the crankcase) with pressure switch attached, taking care that the plunger with spring does not drop out. The cylinder head should now be taken off by unscrewing the nuts which secure it. In lifting the head, every precaution should be taken to raise same evenly, so as to obviate any damage to the studs. With the head removed, now take out the short intermediate shaft which drives the ignition distributor.

The engine can now be turned upside-down, after draining the oil from the sump, and the sump removed. The oil pump can be dismantled by removing the nuts which fix the flange of the pump bearing, and the casing which registers the pump in its correct position. This flange bolts on to

the centre main bearing cap and therefore no alteration whatsoever should be made to this, otherwise the position of the pumpshaft will be affected.

The flywheel disc, which is spigoted on the crankshaft, should next be removed, but between it and the crankshaft flange is fitted a helical spur wheel for driving the camshaft. A hole is provided in the flywheel disc to show the position of the marks on the timing-wheel teeth for reassembly. Therefore, when the nuts are removed from the bolts that secure the disc, this wheel can also be removed, but not the bolts, as these can only be withdrawn when the crankshaft is dismantled. The clutch casing can now be removed and the large hexagon nut with starting-pin which is fitted to the front end of the crankshaft. The fan driving pulley should then be drawn off by means of the special tapped holes which are provided for this purpose.

The connecting rods and pistons should next be removed, after taking off the big-end bearing caps. Then take off the main bearing caps and the crankshaft is ready to be lifted out of the crankcase. When removing the connecting rods, the caps should be replaced in their proper positions. They are marked, so as to make quite sure that the connecting rod and cap are paired up correctly. In original manufacture, each rod and cap is machined together and therefore they are paired exactly, to provide a proper round housing for the bearing. In view of this, it is not possible to interchange bearing caps with different rods.

The valves should be removed, by compressing the valve springs with a suitable valve lifter and extracting the cotters. Then remove the camshaft thrust-housing and endplate and withdraw the camshaft through the rear bearing.

The remaining work of dismantling is a simple matter.

Reassembling Engine

Before commencing the rebuilding of the engine, every part must be thoroughly cleaned. Care should be particularly taken to clear away any deposits in the water ways of the cylinder, which may restrict the free circulation of the water and thus give rise to overheating troubles. This can be best carried out by removing the plate fitted to the side of the cylinder block, which is provided to give access to the interior of the water jackets. The water-distribution pipes should also be removed, thoroughly cleaned, and refitted. These pipes supply cooling water from the radiator direct to the exhaust-valve pocket areas.

Fitting the Crankshaft

The crankshaft is the first major part to be refitted. Before this is started, make sure it is thoroughly clean, as this is very important when rebedding the shaft into its bearings. New bearings should be assembled with dowel pegs complete, in exactly the same way as those that came out

—that is, with the numbers properly paired up. The bearing shells should be a tight fit in the crankcase housings, so as to ensure a good contact of the two metals all round, thereby dispersing the heat generated in the bearings.

The bedding of a crankshaft in new main bearings is, of course, an expert's job, and has to be done properly or trouble will very quickly occur. The bearings can be either hand-scraped to provide accurate fitting, or the more modern practice is to bore the bearings in line with a special tool, which will provide a good bearing with the necessary running clearance of ·002 in. The centre main bearing should receive particular attention, as this incidentally takes the thrust of the engine and has therefore more to do than the other bearings. This should be provided with at least ·004 in. allowance for end float.

Whilst it is always very important that main bearings are a really good fit, they should never be fitted too tightly so that the engine is stiff. Properly fitted bearings should allow the crankshaft to be rotated by hand without undue effort.

Fitting the Big-end Bearing

After fitting the main bearings satisfactorily, the next operation is to fit the big-end bearings, which, of course, is a very similar process. Here again, care should be taken to ensure that the bearings are not too tight. They should be so fitted that with the bearings properly bolted up, the connecting rod can rotate quite easily by its own weight. The end-float allowance for the big-end bearings should be ·004 in.

Flywheel Fitting

Having satisfactorily dealt with all the crankshaft bearings, and properly secured the shaft in the crankcase, fit the spiral gear pinion to the rear end of the crankshaft according to the marks, but do not split-pin up. Next, fit the flywheel disc, after making quite sure that the parts are quite clean, as dirt between the flywheel faces will cause the flywheel to run out of truth.

Also it is very important here that all parts be assembled correctly to the marks on the crankshaft, timing wheel, and flywheel disc to ensure the correct position of the flywheel rim for setting the valve timing, etc. Having done this, the nuts can now be fitted to the securing bolts and split-pinned. The fan pulley and large hexagon nut carrying the starting-handle pin can now be fitted to the front of the crankshaft.

Fitting Up Camshaft

The camshaft should be fitted next, after the tappets have been placed in position. Care should be taken to ensure that the camshaft is a good fit in the crankcase bearings, as any slackness here will cause a reduction in the oil pressure owing to the fact that the oil passes through the cam-

shaft in its circulation. A slight end play of ·004 in. should be allowed. The oiling system should now be reassembled after a careful overhaul of all parts concerned. Extra care should be taken to ensure that the oil relief valve is quite clean, as the presence of any foreign matter in this important unit is likely to cause obstruction to the valve ball seat and allow the oil to bypass back to the sump instead of through its correct channels.

Pistons

The connecting rods and pistons can now be fitted. The pistons should be covered with oil and inserted in the cylinder bores with the split in the skirts to the nearside of the engine. This is important. The big-end bearings should also be oiled, fitted to the crank pins, tightened up, and carefully split-pinned. Cleanliness is very essential in these operations to ensure good results. Grit or foreign matter can do a lot of harm.

Refitting Valves and Springs

The valves and springs can now receive attention. Timing is as follows: inlet opens T.D.C., closes 45° after B.D.C.; exhaust opens 45° before B.D.C., closes 20° after T.D.C. The flywheel rim is marked to indicate the top dead centres of pistons Nos. 1 and 4. These marks can be seen through the plug hole at the top of the flywheel housing. Now, No. 1 piston should be set at top dead centre and the inlet and exhaust valves of No. 1 cylinder dropped into position, but without the springs. With the tappet on the back or neutral part of the cam, adjust the tappets: inlet clearances should be ·012 in. and exhaust clearances ·015 in. With the later-type engine—namely, the C-type engine—the correct tappet clearances are ·030 in. for both inlet and exhaust valves. Then turn the camshaft until the opening of the inlet valve agrees with the above timing. Set the camshaft wheel and secure it in position. The original markings for setting should now agree. Check the setting again and finally tighten the timing-wheel setscrews and wire up securely. The valve timing now having been settled correctly, the valves and springs can be completely assembled.

Cylinder Head

The cylinder head can next be fitted, but before doing so, the precaution should be taken to see that both the machined face of the head and the cylinder block are quite clean, also that the gasket is in good order if a new one is not utilised. Apply a good liquid jointing and tighten down cylinder-head nuts carefully and evenly, until the head is quite tight. These nuts should be retightened again after the engine has had a test run.

The completion of the assembly can now be proceeded with, and it is recommended that all gaskets are renewed to ensure good contact joints

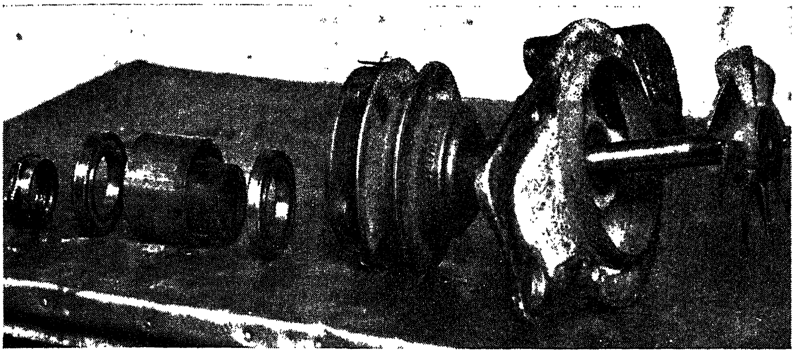


Fig. 1.—ORDER OF ASSEMBLY OF THE FAN AND WATER PUMP UNIT

being made. It is important to particularly take care that good joints are made between the oil cooler and the crankcase, as leakage of oil at this point may starve the engine in a short space of time, with perhaps serious results.

Assembling Fan and Water Pump

The fan and water pump are built in one unit and is designed on modern lines with a carbon gland. In rebuilding this unit, first of all fit the felt washer to the rear end of the fan body, then fit the rear bearing and the two distance sleeves, making sure that the oil inlet in the inner sleeve is at the top. Add the second or front bearings, fit these parts to the sleeve of the fixed portion of the pump body and secure the nut and spring circlet. Now add the two plates which house the felt washer, together with the washer, to the body, and fit the spring-end cap (or dog) together with the fan blades. Place the carbon ring in position with the bevelled edge inwards. Great care should be taken in fitting this carbon ring, as it must be a good fit in its recess to prevent leakage. Furthermore it must be handled carefully to prevent cracking. In fitting, the spindle can be used to guide the carbon ring into place. By gently tapping the spindle with a wooden mallet the carbon can be properly seated. Next, oil the pump spindle and insert in position, pushing it through as much as possible. The driving dog can now be fitted and finally, the special spring circlet, making quite sure to draw the dog over the circlet, to retain this securely in position.

It should be noted that the dogs must engage freely with each other, as otherwise the free action of the spring will be interfered with. The whole unit can now be assembled to the cylinder block and secured in position, and the fan driving belt fitted at the same time.

Fitting Ignition Distributor

When the engine has been all correctly assembled, the ignition distributor has to be finally fitted. To do this, turn the engine in order to bring

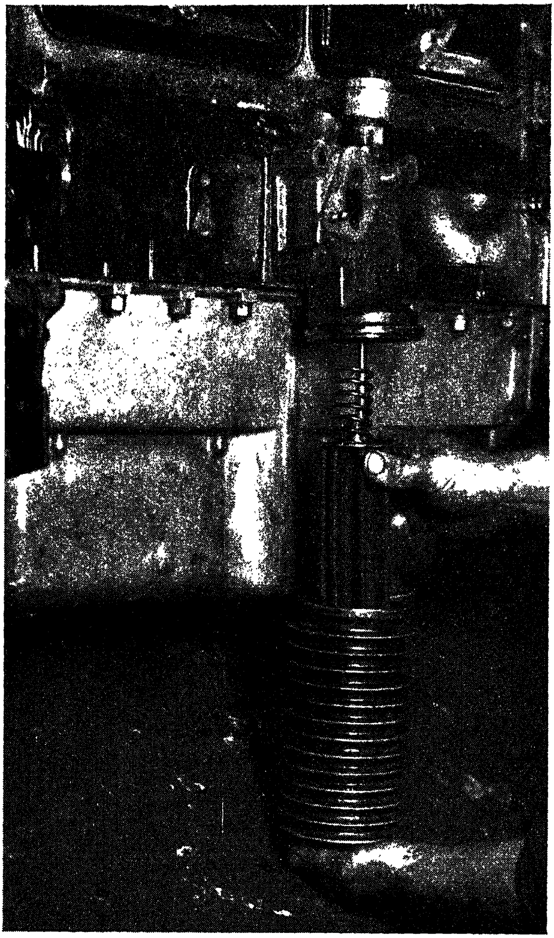


Fig. 2.—REMOVING OIL FILTER ELEMENT FOR CLEANING

No. 1 piston to top dead centre on the compression stroke, and ensure that the intermediate shaft is in position. The dogs are specially offset to allow for correct engagement. Now fit the distributor complete with mounting, connect up the vacuum control between the distributor and carburettor, and set the distributor finger by rotating the distributor body to No. 1 segment, with the contact-breaker point just about to open. Connect up the high-tension wiring to coil and sparking plugs, and give a final check over to the whole assembly.

Oiling System

The oil pump is situated in the sump and is driven by skew gear off the camshaft. The oil is forced through the oil-pump housing through a passage to the special oil-cooling and filtering chamber which is fitted outside the engine crankcase. This chamber is cast with special cooling fins to help maintain the oil at correct working temperature. The pressure from the pump forces the oil through the special fabric element contained in this cooling chamber, and thus filters all fine foreign matter from the oil before it passes on to the engine parts. The oil next passes into a tube situated in the centre of the oil-filter element and then via a passage at the top through to the hollow camshaft. From the camshaft, the oil next passes through special oil channels to the crankshaft main

bearings and thence by means of diagonal ducts in the crankshaft to the big-end bearings. A small hole is provided in the connecting rod which registers once every revolution with the duct supplying the big-end bearing. When this occurs, a jet of oil is squirted into the cylinder bores to provide positive lubrication to these.

There is a special provision made at the rear main bearing to allow for oil to pass through to the clutch shaft. Lubrication is given to the timing gears by means of a jet taken (under pressure) from the rear camshaft bearing.

Close to the oil passage to the camshaft is fitted the oil-release valve. This valve regulates the pressure of the oil as delivered over the whole of the engine. It is not adjustable and should not be interfered with, as it is set correctly by the manufacturers, so as to maintain the proper pressure suitable for the engine.

The oil-pressure switch is fitted to the near side of the engine and is connected electrically to a tell-tale light in the instrument panel on the steering column.

It is most important that the oil-filter element is regularly cleaned, as the whole of the oil in the engine passes through this and therefore it is prone to become clogged with dirt and lose its value and possibly give rise to serious trouble.

In view of this possibility, as a safeguard, a bypass valve is provided in the filter which comes into operation should a stoppage through foreign matter occur in the oil-filter element. This allows the oil to be bypassed into circulation, but as the oil is not in these circumstances being filtered, dirt is passing, which will, of course, bring about increased wear to the bearings, etc. It cannot therefore be emphasised too strongly the importance of regularly cleaning this filter element.

CLUTCH (CONE TYPE)

The majority of Dennis lightweight goods vehicles are fitted with a clutch of the internal-cone type. This type of clutch has only just been superseded on new models by a plate-type clutch. With the internal-cone type clutch, the rim of the flywheel is bolted to the flywheel disc and forms the external driving cone. There are eight pressure springs, each of which is held in position by a recess in the flywheel disc and by a spring retaining plate at one end and by a raised circular projection at the other. Four of these springs are of right-hand coils and the remainder left-hand. The inner or driven cone, which is made of aluminium alloy, is lined with a special friction fabric. The cone is attached to the flange formed on a sliding sleeve, which also carries the two ballraces for declutching and the clutch brake disc. At the front end is fitted the spring pressure plate that is carried on the front ball bearing.

The clutch sleeve has internal splines and is the part that transmits

the power developed by the engine through the clutch to the gearbox. This sleeve is operated by pressure applied on the declutching trunnion by means of the clutch lever, which, of course, is in turn operated by the clutch pedal.

Lubrication

The lubrication of the clutch is arranged by taking a small quantity of oil from the rear main bearing supply by means of a tube which is pressed into a small passage in the crankshaft. This tube rotates in the end of the clutch shaft, which is worm-grooved so as to pass the oil to the oil ducts of the splines and sleeve, also the clutch withdrawal, etc. The oil then passes along the splines of the clutch shaft into the spring pressure plate which diverts the oil to the front bearing. The oil under pressure then proceeds to lubricate the roller spigot bearing and also a quantity is sprayed inside the clutch case to provide lubrication to the other working parts of the clutch, and also to cover the clutch-cone liner with a very fine layer just sufficient to prevent fierce engagement.

The used oil returns to the base of the clutch casing and is returned to the crankcase by means of the flywheel rotating and throwing same through an inclined trough.

On some of the earlier models of this type, difficulty was occasionally experienced with the gearbox oil flowing into the engine sump excessively, and thereby reducing the normal oil-level in the gearbox. The possibility of this trouble has now been eliminated on later models by an alteration in the method of supplying oil to the clutch and gearbox. The clutch shaft and primary pinion is now drilled through its axis, so that the engine oil is pumped through the clutch shaft into the gearbox. An oil-level hole is drilled in the gearbox casing at a predetermined height and this allows any surplus oil to overflow back into the clutch casing, from whence it is picked up by the flywheel and returned to the engine. By this means the oil-level in the gearbox is correctly maintained.

A modification can be carried out on earlier models to obtain similar results by the fitment of a special trough to the wall of the clutch casing. This trough is inclined at an angle, which causes the oil to run down the trough and through a hole (drilled in the case) into the gearbox, the surplus oil returning to the clutch case through the hole.

To Remove Clutch

To remove the clutch for relining or similar attention, first dismantle the gearbox cover and examine the position of the three holes for the long assembly studs. If these are not in line, depress the clutch pedal and turn the clutch cone until they are in line with each other. Now remove the gearbox by first disconnecting the rod joining the clutch pedal to the operating lever, and then remove the setscrews which secure the flanged faces. The clutch fork and levers will come away with the gearbox clutch

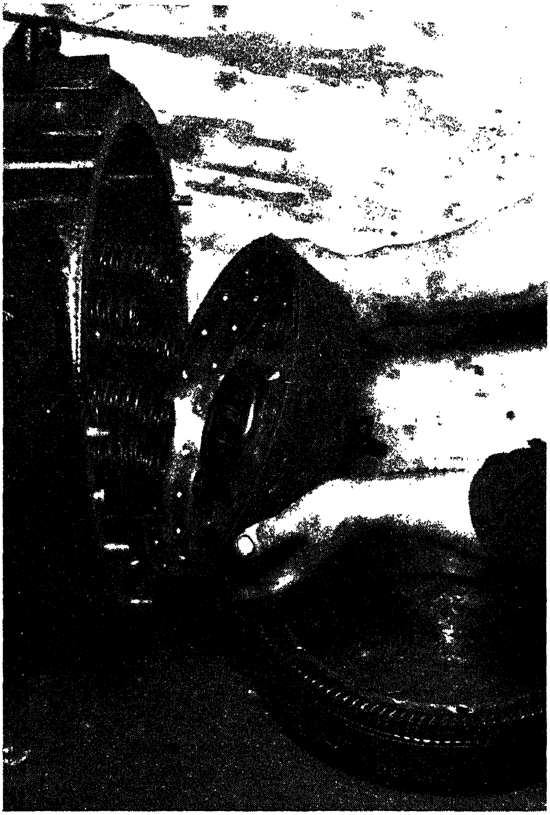


Fig. 3.—REMOVING THE CLUTCH CONE

shaft. Next, insert three extractor studs in the three holes previously mentioned and fit nuts to same and tighten sufficiently to take the pressure of the springs. The nuts should now be removed from the studs which secure the flywheel rim so that this part can be dismantled. When doing this, take particular note of the peg which is provided for locating the flywheel rim in correct position on the flywheel disc. The nuts should now be eased off the extractor studs until the pressure is off the springs, then remove the studs completely, when the clutch cone and sliding sleeve can be stripped off entirely. Care should be taken to keep the idler spigot bearing free from dirt. The clutch-spring pressure plate and front bearing can easily be taken off from the front end of the clutch sleeve. To withdraw the rear ballrace and declutching trunnion, it will be necessary to remove the spring retaining ring and after this the bolts fixing the clutch cone and clutch brake disc to the sliding sleeve.

Clutch Lining

In fitting a new clutch lining to the cone, it is sometimes found that difficulty is incurred in stretching the liner on to the cone. To assist in getting this into correct position, the lining should be warmed thoroughly. Take particular care that the rivets force the lining into the countersunk holes of the clutch cone.

Reassembling Clutch

To reassemble, first fit the bell housing, making sure that the spray tube lubricating the timing gears is in position. Then see that the tube conveying oil from the engine to the clutch is in position and clean, and that the spring retaining plate is in position with the fixing setscrews properly wired up.

The spigot roller bearing can now be fitted and oiled. Do not on any account use grease.

The sliding sleeve, cone, and brake disc can be assembled, but before doing so examine the ballraces. It will be noticed that these are of special design, and the pressure of the clutch springs and foot pedal must be taken on that portion of the outer ring formed for this purpose. They must not on any account be fitted the wrong way round. Now assemble the unit, making sure that the bolts are tight and split-pinned and that the spring retaining ring is in its correct position. To build up the clutch cone assembly, first insert the spring in the recesses formed in the flywheel disc and spring retaining plate. This will hold them in position. Now offer up the cone assembly and bring the holes into line. If a dummy shaft is available for centring the clutch parts, use it, but there must be a hole in it large enough to accommodate the lubricating tube to avoid damage. The shaft will steady the unit while the parts are being fixed. Place the springs and pressure plate in position and insert the three extractor studs in the holes. Make sure that the springs are seated properly on the raised bosses of the pressure plate. Now screw up the nuts to compress the springs sufficiently to allow the flywheel rim to be placed in position. Fit the rim in place, fit the nuts to the studs, tighten up, split-pin, and, withdraw the dummy shaft. Thoroughly lubricate the splined sleeve, etc., and all is now ready for the fixing of the gearbox complete. Make quite sure that there is always $\frac{1}{2}$–1 in. clearance between the clutch pedal and the footboard.

GEARBOX

The gearbox on the Dennis Commercial vehicles very rarely requires any attention, as it is constructed on very robust lines, both shafts being mounted on ball and roller bearings with an ample reserve of strength. The gears themselves are also very substantial and undoubtedly are designed and manufactured to withstand years of hard work. The box has four speeds which are operated by selector gear fitted to the top cover of the gearbox. The assembly carrying this selector mechanism can be detached for attention if required without disturbing the main box.

Dismantling Gears

With the gearbox removed from the chassis, first remove the primary shaft by taking off the nuts which secure its housing to the front of the

box. The shaft can then be pulled out complete and dismantled. Next remove the nuts which secure the mainshaft rear housing and withdraw mainshaft complete with bearing, etc., leaving the sliding gear in the box to be lifted out afterwards. To remove the reverse shaft it will first be necessary to detach the plate which locks the countershaft, when the reverse shaft can be drawn out by means of the threaded hole which is provided at the outer end for this purpose. The two gear-wheels can also be lifted out at the same time. Next detach the gear selector fork by removing the small spindle that guides it and which is fixed by a taper pin fitted at the rear end and just outside the box.

Having previously removed the countershaft locking plate, the countershaft and gears can now be removed by driving it out with the aid of a hammer and a soft-nosed punch from the rear of the box. When doing this, take careful note of the thrust washers and see they are kept at their respective ends. The remainder of the work of dismantling the gearbox is now a simple matter.

Reassembling Gearbox

Generally speaking, the work of rebuilding the gearbox is approximately a reversal of the procedure of dismantling, but care must be exercised in carrying out the work. Commence first of all by assembling the gears on the countershaft. It is important to see that they are pressed right home so as to allow the spring ring which secures them to fit snugly in its groove with the distance pieces and roller bearings placed in position inside the shaft. Oil the thrust washers and place them in position (the oil will hold them by suction), then insert the chamfered end of the spindle at the rear end of the gearbox sufficiently to engage the thrust washers at that end. The countershaft should now be inserted and when in correct alignment the shaft spindle can be pushed through until its slot is in correct position for fitment of the countershaft locking plate. ·004 in. end float should be allowed to the countershaft. The reverse intermediate gears can now be fitted. Check the bearings to ensure they are clean, thoroughly lubricate same, and place in position. The reverse shaft should next be pushed in until the end is in correct position to receive the locking plate, which can now be fixed.

To fit the primary shaft, first place the oil-thrower disc with the relieved side towards the ballrace on the shaft. Fit the ballrace and locking ring, tighten up securely and fix the wire circlet. The roller spigot bearing can next be placed in position, and with the retaining spring ring inserted in its groove, the shaft can be placed in the box.

To assemble the main shaft, first it is necessary to fit the oil thrower disc, taking care when doing so that the outer diameter (which is dished) is set away from the bearing. Next fit the bearing, ballrace packing washer, speedometer drive, and the housing complete with oil seal in position. The flexible lip of this oil seal should be pointing towards the

bearing. The driving spider can now be pressed on to the shaft and fixed securely.

Before fitting the main shaft assembly into the box, make quite sure that the rear face is clean, also that the ballrace retaining ring is in position. Smear all faces with liquid jointing, place the gears in their correct positions and insert the shaft engaging the splines. Push the shaft through into the roller spigot bearing, fit the housing on the studs at the rear, and tighten up securely. Next fit the reverse selector fork and securely fix the guides spindle for same by driving home the taper pin.

The gearbox is now almost completely reassembled. The gearbox cover with selector mechanism should finally be placed in position, care being taken to see that the reverse selector rod is engaging properly with the top of the reverse gear fork. The gearbox cover should be tightened down securely all round and the movement of the gears carefully tested before refitting gearbox complete to chassis.

HILLMAN MINX ENGINE, CLUTCH, AND GEARBOX

THE following notes particularly relate to the 1939 Hillman Minx. The important differences, as compared with previous models, are referred to at the end of the article.

The fan blades are detachable from the dynamo pulley. During the winter months, it is advisable to remove the fan blades. It should be noted that the fan blades are balanced in conjunction with the dynamo-drive pulley, and the blades must therefore be replaced in accordance with the centre punch-marks which will be found on the flange of the fan and the pulley.

When the fan is removed during the cold weather it is, of course, important that it should not be misplaced, as loss of the fan means replacement of the dynamo-drive pulley also. To eliminate this possibility, if the fan is removed it should be secured to the radiator block by one of the radiator shell fixing studs on the offside.

Distributor

Owing to the coupling at the end of the distributor shaft being unidirectional, it is not possible to derange the ignition timing, providing the clamp for the plate at the base of the distributor is not moved. On the other hand, it is by moving the distributor relative to this clamping plate that the ignition timing is altered when it becomes necessary.

The gap between the contact-breaker points should be ·010 in.

Cylinder-head Gasket

If the cylinder head is removed, it will in most cases be found a true economy to arrange to replace the cylinder-head gasket. It is also advisable to coat the gasket with a substance which will assist in the sealing of the joint at this point. Shell Water-Pump Grease is recommended for this purpose.

To Remove Inlet and Exhaust Manifold

It will be found that, due to the extreme flexibility of the silencer mountings, the manifold can be lifted a short distance with the exhaust pipe still attached, after removing the securing nuts. It should be hooked up in this lifted position by resting it on the manifold-securing studs in the cylinder block. The three nuts securing the exhaust pipe to the manifold are now accessible and can be removed.

Should the joints between the manifold and the cylinder block be removed, care must be taken in replacement, as they can be fitted the wrong way up, so causing a partial blockage of the ports. On the two centre studs dowels are provided and must not be omitted, as it is at these points that the alignment of the manifold to the ports is ensured.

Tappets

A tappet clearance of ·010 in. on the inlet and ·015 in. on the exhaust should be maintained, these clearances being measured when the engine is cold.

To adjust the tappets, it will be necessary to remove the inlet and exhaust manifold. It is also necessary to have a locking device and thin spanners. For speed in service special spanners are manufactured which will give satisfactory service when in continual use.

To Remove Tappets

Remove manifold and valve cover. Turn engine until all tappets in one block are clear of the cams. Remove the two setscrews which locate the tappet block. Lever the tappet block forward by means of a suitable lever inserted between the back of the block and the cylinder wall.

When reassembling, the above operations are reversed. Care should, however, be taken that the tappet block removed from the front of the engine is not refitted in the place of that removed from the rear of the engine, and vice versa.

Valves

Valves should be replaced in their original positions. To facilitate this operation the valves are numbered 1 to 8, starting from the front end of the engine.

It is also advisable to take the precaution of first removing the tappet blocks, and a lintless rag should be laid over the camshaft so that, should any valve cotters become displaced during the removal or refitting of the valves, these do not pass down into the sump.

To Replace Valves

It is sometimes thought to be a difficult operation to arrange that both the split cone cotters are held and located in the groove of the valve stem during the replacement of the valves. In this respect the following hint will be found of assistance. In the first place, the valve-spring compressor should not be so adjusted that the valve-spring coils bind. The lifter should be compressed to the point where the lower end can be rocked. It will then be found that when the lower end of the lifter is pushed inwards, one half of the cotter can be inserted on the inner side of the valve stem. The lower end of the lifter can then be pulled outwards, gripping this half of the cotter and providing adequate space for the insertion of the remaining half of the cotter. When both cotters have been inserted

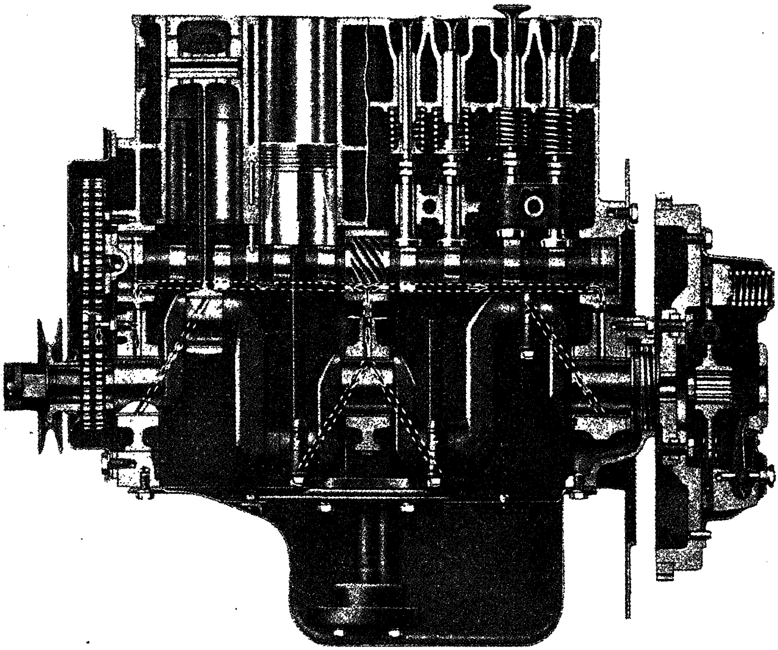


Fig. 1.—LONGITUDINAL SECTION OF 1939 ENGINE, SHOWING LUBRICATION

by this method, the compressor can be released, when the spring cup be lowered on to the cones, gripping them and providing a hammer-free securing device for the cup on the valve stem.

Don't allow wide seats to develop in the cylinder block. If, as a result of cutting, a seat more than 2 mm. wide is obtained, the seat should be narrowed with cutters of 20° and 70°.

Valve-seat Inserts

Special inserts are pressed into the cylinder block to form the seating for the exhaust valves. It will be found that these hardened inserts give very satisfactory service when subjected to prolonged use. If it is necessary to cut these seats, it will be found that this cannot satisfactorily be carried out with an ordinary valve-seat cutter, and we suggest that the operation should be done with a valve-seat grinder.

If at any time it should be necessary to fit replacement inserts, it is recommended that the old insert should be broken for removal purposes, and the new insert pressed or driven in with a suitably shaped drift. Having fitted the insert, the edge of the cylinder block should be rolled over into the chamfer provided on the insert. In the absence of a special tool for this work, a blunt centre-punch may be used satisfactorily.

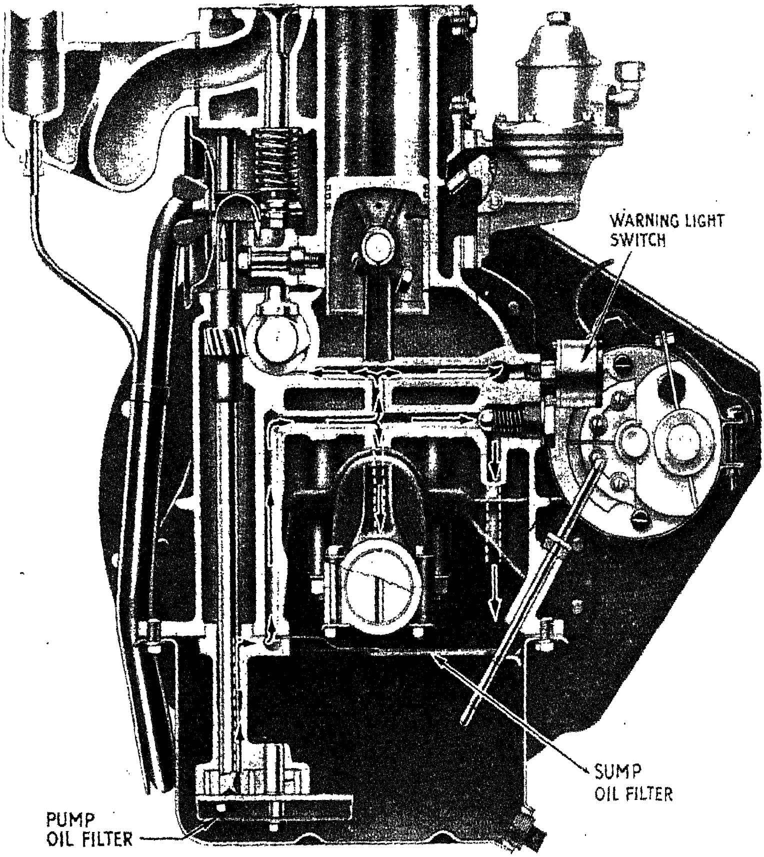


Fig. 2.—CROSS SECTION OF 1939 HILLMAN MINX ENGINE, SHOWING LUBRICATION

Timing

The timing marks on the timing wheels line up at Nos. 1 and 4 top dead centre, No. 4 cylinder being on the point of firing. The key in the crankshaft is at the top centre when this point is reached, and the hole drilled for the tab washer of the setscrew securing the camshaft wheel to the camshaft is in line with the marked tooth on this wheel. With this information, no difficulty will be experienced in replacing the camshaft timing chain even if the radiator is in position.

It is suggested that the timing can be most easily checked by the preparation of a disc constructed in accordance with the diagram, see Fig. 3.

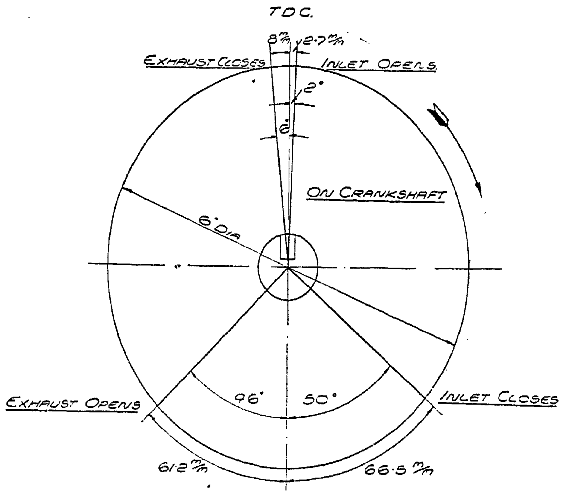


Fig. 3.—DISC FOR CHECKING VALVE TIMING
Measurements to be made round the circumference of a 6-in. diameter circle with the tappets set at 0·018 in. clearance. Note this is not a timing diagram. See text.

This disc is then secured to the crankshaft and a pointer arranged to read on its outer circumference, the disc being located by the key already mentioned. The millimetre measurements given in the diagram will naturally be correct only on a circumference the diameter of which is 6 in., and are recorded as being more accurate than measurements taken of the angles by means of a protractor.

When checking the timing, it is necessary to increase the tappet clearances to ·018 in. This is done so that the reading is taken on the quick-lift part of the cam, where a small movement of the shaft will make an appreciable difference to the lifting of the valve.

Timing Cover

On the base of the crankshaft fan pulley, a spiral oil groove is turned so that it operates as an oil retainer at this point. This form of oil retainer will operate satisfactorily only if it clears the bush in the timing cover. When the timing cover is replaced, therefore, care must be taken to centralise it about this point.

To Replace Timing Cover

To ensure an oil-tight joint it is, of course, essential that the paper packing washer fitted between the timing cover and the plate on the cylinder block should be in good condition.

Place timing cover in position, locating with one or two of the fixing nuts and bolts, which should be inserted but not tightened. Place fan pulley in position and secure with starter dog.

Replace all other setscrews or nuts and bolts securing timing cover, tightening until the timing cover is just nipped, but is not secured. If the engine is now run with the timing cover in this condition, it will be found that the cover centralises itself about the fan pulley, so that when

the securing setscrews and bolts are finally tightened the oil retainer operates satisfactorily. ·003-in. to ·005-in. clearance must be left at this point.

Oil Filters

Upon removing the sump two filters will be exposed. The main filter consists of a gauze tray secured to the sump by four setscrews. At intervals of 6,000 miles this gauze should be removed and any sludge found in the sump should be completely washed away with paraffin, great care being taken to dry the sump thoroughly before replacement. The main oil filter should be thoroughly cleaned with paraffin at the same time.

A secondary oil filter is provided for the intake of the oil pump. This is secured by a nut which should be removed, when the filter can be detached and cleaned.

Oil Pump

At the top of the oil-pump shaft a uni-directional coupling is provided for the distributor drive. It is therefore essential that great care should be taken when the oil pump is replaced. On all occasions when it is necessary to remove the oil pump, the engine should be first turned to Nos. 1 and 4 top dead centre, No. 4 firing, and of course the oil pump should be replaced only when the crankshaft is in this position.

To Remove Oil Pump

Remove sump. Turn engine to Nos. 1 and 4 top dead centre, No. 4 firing. Remove setscrews securing oil pump to cylinder block. Draw oil pump downwards.

To Replace Oil Pump

Turn oil-pump shaft so that slot of the uni-directional coupling lies at right angles to the line taken across the securing-bolt holes, the smallest segment being to the front of the engine.

Make sure that the engine is at No. 4 firing top dead centre.

Place oil-pump shaft into position in hole in cylinder block and line up fixing holes in oil pump with fixing studs in cylinder block. Do not omit the oil baffle, which is fitted between the pump and the cylinder block.

Push oil pump straight home, when it will be found that the drive gear unites with the correct teeth, causing the pump shaft to rotate and assume the position shown in Fig. 4.

If the precaution was first taken to locate the crankshaft in the correct position before pump removal, no difficulty should be experienced in carrying out this operation without the removal of the distributor.

The procedure for replacing the oil pump, given above, applies only to

the 1939 models in which the second high-tension wire from the distributor is taken to No. 1 plug.

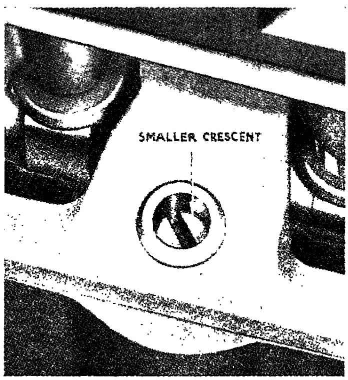


Fig. 4.—DISTRIBUTOR POSITION AT NO. 4 FIRING T.D.C.

Pistons

All Minx engines are fitted with pistons made from a special alloy known as "Lo-Ex," being a derivative of the name "Low-Expansion." This special alloy has not only a low coefficient of expansion, but is lighter than aluminium and retains its physical properties, i.e. its strength, at high temperatures. It will be seen, therefore, that it is unequalled as a piston material.

In the skirt of the piston a T-shaped slot is cut, and this should be fitted on the side of the engine opposite to the camshaft. All pistons are numbered 1 to 4 to ensure the correct replacement in the bores. They also are stamped with a letter which indicates the piston size to one-hundredths of a millimetre, and is used in connection with the selective piston assembly used in the production of all Minx engines.

The Principle of Selective Piston Assembly

It will be appreciated that in production it is possible to hone any cylinder only within certain limits, and in order to ensure an absolutely correct piston fit a system of marking is employed whereby it is possible for the correct size of piston to be fitted into any cylinder bore. The range consists of A1, A, B, C, C1, C2, C3. The variation between each of these sizes is one-hundredth of a millimetre, which is actually less than ·0005 in. The size B is exactly 63 mm. A bore one-hundredth of a millimetre less than 63 mm. is marked A, two-hundredths less A1, and, similarly, a bore one-hundredth of a millimetre larger than B would be marked C. Production engines are never fitted with pistons larger than C. The pistons C1, C2, and C3 are therefore available should it be necessary to absorb slight bore wear.

The principle upon which these pistons could be used is this. Take the mileage of the car in thousands. Then take a grade larger piston than the one removed for each thousand miles the car has covered, e.g. after a car has covered 4,000 miles and the piston removed is marked B, a C3 piston can usually be fitted.

Cylinder wear is never even, the greatest wear taking place at the top of the cylinder bores. It is therefore unsatisfactory to regard this range of pistons as being usable when it is necessary to absorb the normal wear which must inevitably take place as the result of large mileages covered.

For this purpose a stock of definite oversize pistons is available, and it will be necessary to have the cylinder bores accurately reground to take these pistons. This range is plus ·005 in., plus ·010 in., plus ·015 in., plus ·020 in., plus ·030 in., plus ·040 in.

Precision-made Bearings

Wear cannot be absorbed by filing the bearing caps, as this would render the caps entirely useless when replacement bearings become necessary.

When eventually it becomes necessary to absorb the results of wear, the crankshaft must be removed and accurately reground to take one of the undersize bearings, in exactly the same manner as the cylinder bore is rebored to take oversize pistons. The undersizes obtainable for both the mains and the big ends are minus ·010 in., minus ·020 in., minus ·030 in., and minus ·040 in.; the crank sizes new being journals 1·75 (+ ·000 − ·0005), crankpins 1·625 (+ ·000 − ·0005).

Replacement crankshafts and bearings are obtainable from the factory.

Connecting Rods

The connecting-rod bearings are detachable, and being precision bearings must be renewed without any hand fitting or scraping operation being introduced. It is, of course, important that the caps should not be filed at any time. Connecting rods are numbered to ensure correct replacement and they should be fitted with this number towards the camshaft.

Draw out piston and connecting rod on the nearside of the engine.

The question of replacement connecting rods will seldom arise, owing to the fact that the wear takes place solely on the detachable bearings, which are replaceable in accordance with notes already given. Should it be necessary to replace a connecting rod for any reason whatsoever, it is essential that the alignment be checked before the connecting rod is fitted. For this purpose universal jigs are available and essential.

Care should also be taken that the piston and connecting rod are replaced the correct way round, i.e. numbers on connecting rods towards the camshaft; the slot in the piston away from camshaft.

It is also a matter of extreme importance that new tab washers should be fitted to the big-end bolts whenever the above operation is carried out.

Fitting Piston

Before the gudgeon-pin clamping screw can be refitted, it will be necessary to see that the groove in the gudgeon pin is in line with the clamping-screw hole. It is definitely inadvisable to use the clamping-screw tab washer a second time, and special care should be taken to see that this screw is securely tightened and the tab washer bent over carefully.

To Remove Engine from Chassis

Removal of the engine from the chassis is seldom necessary. Replacement main bearings are fitted without any ordinary hand-scraping operations being necessary, and actually the pair of bearings at any one point can be changed without removing the crankshaft.

It has been found advisable to remove the gearbox before the engine is taken out of the chassis frame.

It is necessary to use a hoist to take the weight of the engine. For this purpose the construction of a simple form of metal strap is recommended. This consists of a strip of mild steel 1 in. wide by $\frac{3}{16}$ in. thick, which is bent into the form of an inverted V and is secured to two of the cylinder-head studs. It should be arranged so that the hoist operates from a central point on the cylinder head.

Main Bearings and Crankshaft

The Minx crankshaft is carried on three large-diameter white-metal bearings run into steel shells, which are very accurately machined so that no fitting or scraping operation is either necessary or permissible.

These bearings are not dowelled except by a small ear, which can be seen when the lower half of the bearing is removed. Should the necessity arise, therefore, the top and bottom half of any one pair of bearings can be removed without removing the crankshaft, i.e. the top half will slide round the crankshaft.

At the rear main bearing detachable bronze flanges are fitted, the flange at the rear being thicker than the flange at the front face. These flanges are in two halves. The top half of the thick flange at the rear is dowelled on the clyinder block only, so that this half is not detachable without first removing the crankshaft. On the other hand, the front flange, which is also formed in two halves, is dowelled to the bearing cap alone, and thus with only the bearing cap removed, the top half of this front flange can be pushed round and withdrawn without first removing the crankshaft.

These two pairs of flanges control the end float of the crankshaft, and it is suggested that if it is necessary to adjust the end float, in most cases this will most easily be carried out by fitting slightly oversized flanges to the front of the bearing, which can be adjusted to provide the necessary end float, care being taken to rub these flanges down evenly on a piece of fine emery cloth laid on a surface-plate. The correct crankshaft end float is ·003 in. to ·006 in.

The crankshaft may be withdrawn without removing the engine from the chassis.

It will be appreciated that owing to the possibility of withdrawing the crank without removing the engine, and owing, furthermore, to the precision-made bearings, a complete crankshaft bearing overhaul can be carried out with the engine still in the chassis.

CLUTCH AND FLYWHEEL

Adjustment

The clutch is a Borg and Beck. There is only one external adjustment, which should be checked over periodically. This adjustment concerns the clearance between the round-headed bolt on the withdrawal lever and the clutch pedal. When correctly set the clearance between the lug on the clutch pedal and the adjusting-screw head in the rocker shaft should be $\frac{3}{32}$ in.

To test this the lever must be pulled backwards against the return spring attached to the withdrawal lever. The clearance at this point is important, and under no circumstances should this clearance be reduced, as there will then be a tendency to hold the clutch out and cause slip.

Flywheel

The starter gear ring on the Minx is shrunk on to the flywheel, and in the event of wear developing on the teeth the ring can be replaced.

When replacing the flywheel, care must be taken that the 1/4 marking is opposite the hole in rear engine plate when the engine is at Nos. 1 and 4 top dead centre. The flywheel should fit squarely on to the crankshaft, and the four setscrews securing the flywheel should be fully tightened and locked with new locking plates.

To remove and refit starter ring, cut through the ring with a chisel so that it may be opened and removed from the flywheel. It is important that the small lip which positions the starter ring on the flywheel should not be destroyed during this operation. Warm the replacement starter ring to a temperature of 430° C., and place in position on the flywheel. Allow to cool.

After this operation has been completed and the ring has finally cooled, it is advisable to test the truth of the clutch face of the flywheel, skimming this up if necessary.

GEARBOX

A new gearbox was incorporated in the Minx chassis for 1939, the features of this gearbox being that it is shorter and of a more rigid construction than the previous model, and has a much stiffer mainshaft.

Synchromesh is incorporated on second, third, and top. From Fig. 6 it will be seen that third and second gear are in constant mesh ; first and reverse are obtained by means of sliding gears, and direct drive is obtained on top gear.

The only work which can be carried out on this gearbox whilst it is in the chassis, apart from filling with oil and draining, is the removal of the top cover and the rear cover. Should it be necessary to attend to the gearbox in any other way, it must be removed.

Gearbox Overhaul

It will be found that very few special tools are necessary to carry out the work on this new box, although it is essential that a dummy shaft be obtained for use in the layshaft. This shaft should measure $\frac{3}{4}$ in. in diameter and should be exactly $6\frac{3}{16}$ in. long.

After lifting off the bell housing, hold gearbox in vice by flats on drain plug and take off top cover.

Remove split-pin from nut securing rear coupling, push both outer selectors forward to engage two gears at once, remove nut from rear coupling and take off the rear coupling.

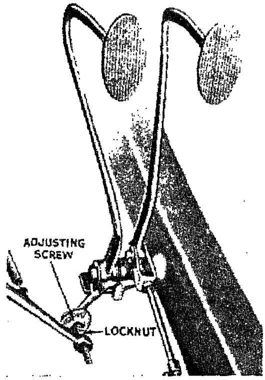


Fig. 5.—EXTERNAL CLUTCH ADJUSTMENT

Remove the rear cover and slide from mainshaft the sheet-metal oil thrower, the speedometer wheel, and a distance-piece. Remove setscrew securing locking plate of layshaft and reverse shaft and take off locking plate.

Push dummy shaft against end of gearbox layshaft, thus extracting the layshaft and inserting the dummy shaft. When correctly inserted the dummy shaft will hold the needle rollers and the steel thrust-washers of the layshaft and allow this to drop into the lower portion of the gearbox *en bloc*. The bronze thrust-washers will remain in position on the gearbox casing. Remove three nuts from ends of selector shafts.

Push out selector shafts carefully to avoid loss of selector balls. Lift out first and second, reverse, third and top, gear selectors. Remove setscrews securing front cover to gearbox. Remove first motion shaft assembly, and third and top synchromesh assembly from mainshaft.

Drive mainshaft towards front of box from rear bearing and withdraw through front of box, leaving the first gear and second gear synchromesh assembly in the box, which can be lifted out.

Lift up the layshaft complete with dummy shaft, etc., taking care to keep it horizontal so that the dummy shaft does not become displaced.

Remove layshaft cluster complete through front of box, and then shaft carrying reverse sliding gears and reverse gears.

On the rear coupling there is an oil-return spiral. This must clear the case by a minimum of ·003 in. and a maximum of ·005 in. Any paint in the rear cover at this point should be carefully scraped away.

End float of speedometer drive wheel is important. If excessive it is liable to cause pumping of oil up the speedometer cable. It should not, however, be reduced below ·004 in.

To Dismantle Third and Top Synchromesh Assembly

Holding the outer member, tap the inner member lightly with a mallet and release the six balls from groove turned in outer member.

Cover assembly with a rag to catch the balls. Push inner member from outer.

Reassembly

To reassemble, it will be necessary to hold these balls compressed. This can be carried out with any suitable form of slip-ring, and a radiator hose clip can be used for this job.

To reassemble, build the shims (if any), springs, and balls into the inner member, secure the clip, engage in outer member, push inner member well in so that the balls engage in groove on outer member.

The outer ring of this assembly is symmetrical and thus the assembly cannot be built incorrectly. It must, however, be fitted to the mainshaft with the boss on the inner member towards the first motion shaft.

To Dismantle and Rebuild Mainshaft Assembly

Remove circlip securing thrust-washer to mainshaft and remove thrust-washer. Lift off third gear. Remove floating thrust-washer, second gear, and last thrust-washer.

Whilst the rebuilding of this is a direct reversal of the above, it is most important that when assembled there should be ·006-in. end float on this gear assembly. The amount of end float is adjusted either by the thickness of the circlip or the thrust-washer immediately below it. It will be appreciated, therefore, that the end float can be quickly adjusted without re-dismantling the whole of the assembly. Whenever this assembly is dismantled the circlip should be replaced. As the circlip may not be absolutely flat a false reading of end float can be obtained. The end float should therefore be checked between the thrust-washer and the circlip, using a narrow feeler at two or three points.

To Dismantle and Rebuild First- and Second-gear Sub-Assembly

Mal-assembly of this sub-assembly can very seriously affect the whole performance of the gearbox and can result in very bad cone rubbing whilst first gear is engaged, or in completely eliminating the synchromesh action of the second gear cones. Furthermore, it can cause the box to stick in first gear. On the other hand, if the following notes are carefully studied, none of these difficulties can arise.

Having covered the assembly with a rag to prevent loss of synchromesh balls, push outer member from inner member. It will then be seen that over and above the six spring-loaded balls which provide the pressure for the second-gear synchromesh, there is also a plunger and ball in a seventh hole in the inner member. The function of this plunger is to lock the inner member to the mainshaft when first gear is engaged, and thus stop the inner member being pushed on to the second-gear cone. It will be appreciated, therefore, that if this plunger is not operating whenever first gear is engaged, the second gear cones will be rubbing.

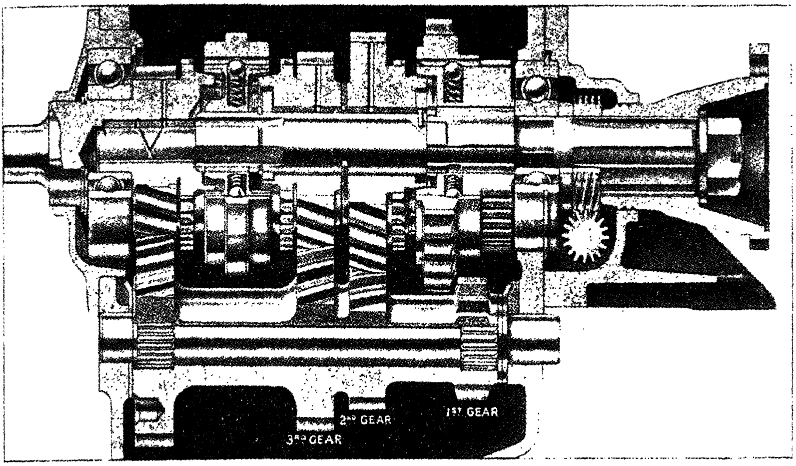


Fig. 6.—CROSS SECTION OF GEARBOX

On the other hand, it is obvious that the cones must engage when second gear is required, and thus when second gear is in operation this plunger must *not* lock the inner member to the mainshaft.

An examination of the outer member will reveal that one of the internal teeth is cut away from the groove in which the synchromesh balls operate to the rear of the outer member. This tooth is the one which must operate the plunger, and as will be seen from the notes already given, it is of paramount importance that when rebuilding this sub-assembly this cut-away tooth fits exactly over the top of the ball which caps the plunger. This point is shown in a slightly distorted drawing, Fig. 7, which has been prepared specially to illustrate the point.

Adjusting Length of Plunger

Apart from the above notes on these plungers, the length of the plunger is important and different lengths are sometimes necessary. Before reassembling the above, the length of the plunger should be selected as follows:

Place plunger and ball into inner member. Place the outer member on to inner member without synchromesh balls in position. Place this assembly on to mainshaft. Push outer member from the neutral position so that plunger is depressed. Push inner member towards front end of mainshaft, when it should be found that ·010 in. min. to ·020 in. max. end float is left between rear end of inner member and rear end of splines on mainshaft.

If this clearance is not left at this point, the gearbox will tend to stick in first gear.

Having adjusted the length of plunger, proceed with rebuilding as follows:

Place synchromesh shims, if any, balls, and springs in the six holes in inner member. (*See* notes on shims at end of this section.) Place selector plunger in seventh hole and place ball over plunger. Compress springs and synchromesh balls with a slip-ring, as described for third and top synchromesh. Very carefully engage the outer member on the inner member so that the cut-away tooth is directly over the hole containing the plunger with the ball. Push outer member over inner member, displacing slip-ring.

Push further until the balls engage in the groove in the outer member. The sliding gear should then be over the cone in the hub if the outer member has been replaced the correct way round.

To Dismantle and Rebuild Layshaft Sub-assembly

Upon lifting this layshaft cluster from the box and removing dummy shaft it will be seen that the cluster is carried on fifty-four needle-roller bearings, twenty-seven of these being fitted at each end. At the front end a small thrust-washer fits over the ends of the needle rollers, whilst at the rear end is a floating thrust-washer. To rebuild this cluster ready for the reassembling of the gearbox, proceed as follows :

Place dummy shaft in cluster, grease the needle-roller bearings, and push twenty-seven in between the dummy shaft and the cluster at each end. Place thrust-ring on top of needle rollers at front end. On the projection of the dummy shaft at the rear end, place the floating steel thrust-washer.

These thrust-washers are selectively assembled to give the cluster ·006 in. to ·008 in. end float. At this stage, therefore, this point should be checked as follows :

Place the bronze thrust-pads in the gearbox, securing them with a thin coat of grease. Place the layshaft complete, as assembled above, in the box. Check the end float. If incorrect, adjust by changing over the steel thrust-washer. If a new washer is fitted and requires reducing, the washer must be rubbed down on emery cloth placed on a surface-plate, equal amounts being removed from each side. When correct, leave the cluster in the box ready for reassembling.

Note on Reverse Fork

The replacement of this fork will most easily be carried out if the sliding gears are first pushed forward so that reverse gear is engaged. Turn the front end of the fork outwards, when it will be found that it can just be guided into the groove on the reverse wheels. Care must be taken to test that the fork is definitely in the groove before replacing the selector shafts.

General Notes Regarding Gearbox Assembly

The following notes have been prepared of points in the assembly of the gearbox which are important and which have not been definitely included in the preceding paragraphs.

Mainshaft-gear Assembly—Running Clearances

When assembling the second- and third-speed wheel on the mainshaft, it is important that a radial clearance should exist between the mainshaft and the wheels of ·00175 in. in each case.

Clearance of First- and Second-speed Hub on Mainshaft; also First-speed Wheel on Hub

The hub of the first speed should be a good sliding fit on the mainshaft without perceptible "shake," and a maximum clearance of ·0004 in. should be allowed at this point. The first-speed wheel should also fit this hub without perceptible "shake." These two points are of extreme importance, as experience shows that an unsatisfactory fit of these two parts produces a tendency towards overrun gear chatter, jumping out of gear, and also noisy first speeds.

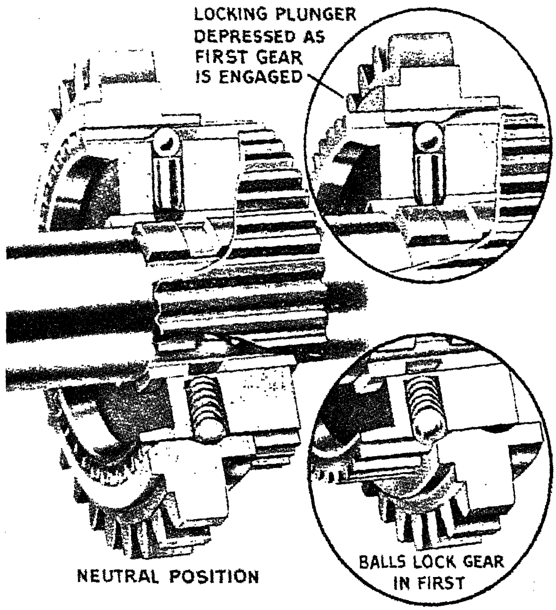


Fig. 7.—SECTIONED VIEW OF FIRST AND SECOND MAINSHAFT GEAR

Showing action of locking plunger.

Alignment of Bearing Bores with Clamping Faces on Gearbox Casing and Front and Rear Covers

It is very important that the above should be carefully watched. It should be possible, when the stem wheel and mainshaft have been assembled into the gearbox, to spin the mainshaft freely when the stem wheel is being held by one hand; this test, of course, being carried out whilst the layshaft assembly is still lying at the bottom of the box. If any binding or stiffness is experienced as the result of this test, this should be investigated, as it is essential that the mainshaft should run free under these conditions, as otherwise unfair cross-binding would occur in the stem-wheel bush and thus lead to possibilities of overheating and seizure. Furthermore, cross-binding of this type would adversely affect the synchromesh action, particularly on changing down.

Care should be taken to ensure that the top cover is positioned correctly on the gearbox during assembly. In order to eliminate the necessity for " shimming " the safety latch inside the tower for the purpose of obtaining the correct operating position of the tenon in the slots in the selector forks, the fixing-stud holes in the top cover have been made a good clearance. When assembling, the nuts should not be tightened up until the gear lever can be moved easily from side to side in the neutral position. This movement should have a smooth feel, free from binding.

Stem-wheel Bush

This should have a radial clearance of ·0015 in. at (*a*) the mainshaft spigot in the bush, and (*b*) the bush in the stem wheel.

Great care must be taken that the ball race is securely fitted in the housing and held by the circlip. Should this circlip come out the stem-wheel end thrust will be taken on the bush, with serious results.

In the assembly of all circlips, particularly the small circlip in front of the third-speed wheel, great care must be taken to avoid overstressing these parts.

It is very important that the locating tag on the thrust-washers should fit squarely into the recess in the casing.

Hand-brake Fulcrum Pin

The portion of this part which fits into the gearbox should be painted over with a quick-drying sealing compound before fitting into the gearbox casing.

Layshaft and Reverse-shaft Spindle Holes in Gearbox Case

To obviate any tendency towards oil leakage, the ends of the above spindles after assembly in the gearbox should be carefully painted over with a suitable quick-drying sealing compound.

Front and Rear Cover—Sealing Compound

The joint faces of the above components should be thinly painted with the same sealing compound as recommended above.

It will be appreciated that a definite load must be placed on the synchromesh cones in order that the action of these may be completed. The load is obtained by the pressure of the springs and balls fitted in the inner member in the groove turned in the outer member. These loads should be 40 to 46 lb. for the third and top, and 50 to 56 lb. for the second gear, and can be tested by holding the outer member and applying the above loads to the inner member.

If the load is found to be less than given above, shims are available which are placed at the bottom of the holes in which the springs are fitted. As a rough guide it should be noted that a shim in three of the holes will increase the load by 10 lb. Shims may be fitted as follows : two shims, one in two holes opposite each other ; three shims, one in each alternate hole ; or six shims, one in each hole.

PREVIOUS MODELS

The previous notes refer particularly to the 1939 Hillman Minx. In the main, the design is the same for the previous models, but varies in minor details, to which attention is now drawn.

Previous to 1939, instead of the flywheel T.D.C. mark, the fan-driving pulley is marked to indicate when Nos. 1 and 4 pistons are at T.D.C. The two pistons are in this position when the marking is vertical.

When refitting the oil pump on 1936, 1937, and 1938 engines, see that No. 4 piston is placed at T.D.C. firing-point, and enter the pump driving shaft into position with the slot at the top of the coupling exactly parallel to the camshaft and the smaller crescent at the side of the slot adjacent to the camshaft. It will be found that when the oil pump is fitted in its correct position the slot at the top of the coupling will be at approximately 1 o'clock, with the smaller crescent close to the camshaft.

Connecting Rods

Previous to chassis No. 1009822 (1938), the numbered side of the connecting rod should be fitted on the side away from the camshaft.

Up to chassis No. 86390, the big-end bearings are of white metal and are run directly into the connecting rods. A clearance of ·002 in. should be maintained on the diameter. The connecting rods are offset, the rod always being fitted so that the " set " is towards the nearest main bearing, i.e. the " set " on Nos. 1 and 4 connecting rods should be always towards the front and rear main bearings, while the " set " on Nos. 2 and 3 rods should be towards the centre main bearing.

A third bearing was incorporated in the camshaft in models from 1938.

Adjustable Engine Mounting

At the rear end of the gearbox in all models, a special bracket is formed to carry the weight of the power unit and arrangements are made for the actual weight to be carried on a rectangular block of rubber. A " U "-shaped piece of rubber is fitted over the rear end of the gearbox, and this is held in position by a metal " U "-clip. The whole of this assembly is attached to the chassis cross-member by means of a suitable bracket held in position by four bolts. On earlier 1936–37 models, the nuts on the engine rear-support strap should be tightened until there is a gap between the strap and the bottom plate of approximately 15 mm. On later models this clearance is set by the use of distance-pieces on the setscrews.

To check for correct adjustment on the earlier 1936–37 models, the engine should be started up and the accelerator pedal sharply depressed from the idling position, when a pronounced oscillation of the hand-brake lever should be noticeable. When testing a car it will generally be found that if the " U "-clip is too slack excessive vibration will be present when the engine is pulling hard at low speeds. Conversely, roughness at high speeds usually indicates that the " U "-clip is too tight, and adjustments should be made accordingly.

FIAT-500 MODEL ENGINE, CLUTCH, AND GEARBOX

Removing the Engine from the Car

THE engine, clutch, and gearbox units cannot be removed separately. Consequently the whole of these three units must be removed whenever there is need to carry out a repairing operation involving the dismantling of any one of them.

Disconnect the battery cable. Take off the front of bonnet and grille of dummy-radiator shell. Open the tap located in front of the cylinder block, to drain the water from the radiator and the cylinder jackets. Disconnect the water hoses from the top and bottom of the radiator. Remove the small bolt fixing the dashboard tie-rod to the upper part of the radiator core, and the two bolts fixing the lower part of the radiator core to the chassis cross-member. In this way the radiator core becomes free.

If the car has not been placed over a pit and if a pit is not available the car must be jacked up at the rear.

Disconnect the propeller-shaft joint on the gearbox and the transmission-brake connecting rod. Remove the bolts fixing the gearbox to the rear support. Disconnect the driving end of the speedometer cable; the dynamo earthing cable from a bolt in the gearbox; the clutch-control rod; the two engine side undertrays; the oil pipe from the engine base chamber; the petrol pipe from the carburettor; the accelerator connecting rod and the starter-motor control cable; the carburettor; the exhaust pipe from the manifold; the cable from the coil; and the dynamo, the electric horn, and the starter-motor cables.

Remove the electric horn, and the cross-member connecting the front ends of the wings.

Unscrew the gear hand-lever from the interior of the car, by means of a tommy-bar placed in the hole provided for this purpose.

Fit a hook to hoist the engine, and connect it to a crane; if no hook is available a rope can be used placed under the dynamo bracket. Remove the front brackets supporting the assembly and remove the assembly by an upward and forward movement.

Fitting the Engine Assembly to the Car

Bring the assembly to the car, having previously unscrewed the gear lever. Fit the front brackets, fixing them to the chassis frame (if a pit is

not available the car must be jacked up at the front). Fit the rear rubber mounting of the assembly, fixing it to the chassis frame.

Connect the propeller shaft to the front flexible joint ; the transmission brake-control rod ; the clutch-control rod ; the dynamo earthing cable to the gearbox ; the exhaust pipe to the manifold ; the oil-pressure gauge pipe to the connection on the engine-base chamber ; and the engine side undertrays.

Fit the radiator core, and connect the rubber hoses to their respective water pipes on the cylinder head and the cylinder block, and fit the carburettor. Fix the accelerator-control rod and connect the starter-motor control cable. Connect the petrol pipe to the carburettor ; the ignition-coil cable to the ignition distributor ; and the dynamo and starter-motor cable.

Fit the front cross-member connecting the mudguards ; the electric horn ; and the gear lever. Connect the cable to the battery. Take care that everything is in working order. Then refill the radiator and fit the front portion of bonnet with dummy-radiator grill.

ENGINE

Dismantling the Unit

Remove the plug of the oil sump and drain it. Disconnect the gearbox from the engine ; also—should it be necessary—the clutch unit. Loosen the small bolt fixing the ignition distributor, so that the latter may be pulled out from its position. Then disconnect the sparking-plug cables ; loosen, also, the nuts fixing the outside flange of the dynamo driving pulley until the belt becomes slack enough and can be removed. Remove the dynamo. Disconnect the water inlet pipe. Remove the starter motor and the sparking plugs.

Disconnect the cylinder head. In conjunction with the cylinder head the distributor driving spindle must also be lifted.

Unscrew the castellated circular nut fixing the dynamo driving pulley. Then remove the pulley.

Remove the valve cover. Dismantle the gears on the camshaft, and thus in this way remove the driving chain.

Disconnect the inlet and exhaust manifold and the union of the oil pipe from the oil-pressure gauge behind facia board. Turn the cylinder block upside down. Remove the sump, the oil pump, and the pump driving shaft.

Remove the big-end caps of the connecting rods and the crankshaft driving pinion. Disconnect the flywheel from the crankshaft. Remove the crankshaft rear bearing and the crankshaft front bearing, loosening the centring bolt, which is hollow to allow a vent to excessive oil pressure.

Remove the crankshaft through the opening of the rear bearing. It is necessary to arrange the connecting rods in such a way that they will not foul the crank webs. Remove the connecting rods with pistons.

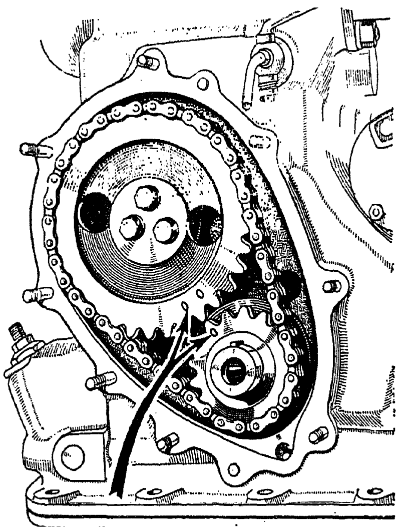


Fig. 1.—REFERENCE MARKS FOR VALVE TIMING

Dismantle the valves. Remove the camshaft, pulling it out from its front end, and remove the tappets from their guides.

Reassembling

Carry out in reverse order the same operations as described for dismantling, setting at the same time valve and ignition timing, as explained in the following paragraphs.

VALVE TIMING

The firing order is 1, 3, 4, 2.

If the Engine is not Fitted to the Car

(1) A quadrant (C. 642), graduated in degrees, can be obtained for simplifying the valve-timing operation. This is fitted to the engine rear support.

(2) Provisionally adjust the clearance between the inlet- and exhaust-valve stems and the tappets of cylinder No. 1 to ·010 in.

(3) Crank the engine till the arrow stamped on the flywheel, and corresponding to top dead centre of pistons Nos. 1 and 4, points, on the graduated quadrant, to 8° advance in regard to the engine direction of rotation.

(4) Rotate the camshaft until the inlet valve of No. 1 cylinder is on the verge of opening.

(5) Make sure that the marks O stamped on the timing-wheel teeth correspond to the mark O stamped on the driving pinion. Then fit the driving chain.

(6) Finally, adjust the clearance between the inlet- and exhaust-valve stems and the tappets to ·004 in. and ·008 in. respectively.

If the Engine is Fitted to the Car

To check the valve timing if the engine is fitted to the car, it is necessary to :

(1) Adjust the clearance between the tappet and the exhaust valve of No. 4 cylinder to ·010 in.

(2) Crank the engine until the exhaust valve of No. 4 cylinder is about to open.

(3) Remove the stud from the head over No. 4 cylinder, and fit in its

place a distance-gauge for checking over the dead centre. A suitable gauge may be obtained from the makers. Push down the gauge stem till it touches the piston, and note the position of the indicating notch. Then turn the crankshaft until the bottom dead centre is reached, and make sure that the gauge-stem travel is 12 mm., with a tolerance of 0·5 mm. more or less.

(4) Having completed the foregoing operations, proceed with the adjustment of the tappet clearance in the usual way.

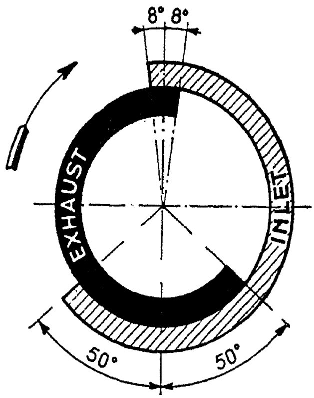


Fig. 2.—VALVE-TIMING DIAGRAM FOR ·010-IN. CLEARANCE BETWEEN VALVE AND TAPPET

IGNITION TIMING

The ignition distributor should be set with 2° initial advance. The advance is automatically controlled according to engine speed. The automatic advance range is 17 and the maximum advance is therefore 19°.

If the Engine is not Fitted to the Car

(1) Fit the graduated quadrant to the engine rear support.

(2) Locate the flywheel so that the narrow indicating top dead centre of pistons Nos. 1 and 4 shows an advance of 2°.

(3) Observe which cylinder is then in the firing-point, and set the distributor-rotor brush on the corresponding contact segment.

(4) Fit the distributor and its driving spindle to the engine, making sure at the same time that the contact points begin to open. The most accurate adjustment will be obtained when the distributor brush is slightly pushed in a direction opposite to the rotation, so as to eliminate any play originating in the automatic advance device.

If the Engine is Fitted to the Car

(1) Remove the stud from the head over No. 4 cylinder, and fit in its place a distance-gauge for checking over the dead centre.

(2) Crank the engine until the gauge shows that the piston of No. 4 cylinder has still to travel about ·1 mm. to reach the top dead centre of the exhaust period. This is a position corresponding to the firing-point of No. 1 cylinder, with a 2° advance in regard to the top dead centre.

(3) Set the distributor-rotor brush on the contact segment corresponding to No. 1 cylinder, and fit the distributor and its driving spindle to the engine. Make sure at the same time that the contact points are about to open. Distributor points should be adjusted to ·017–·019 in.

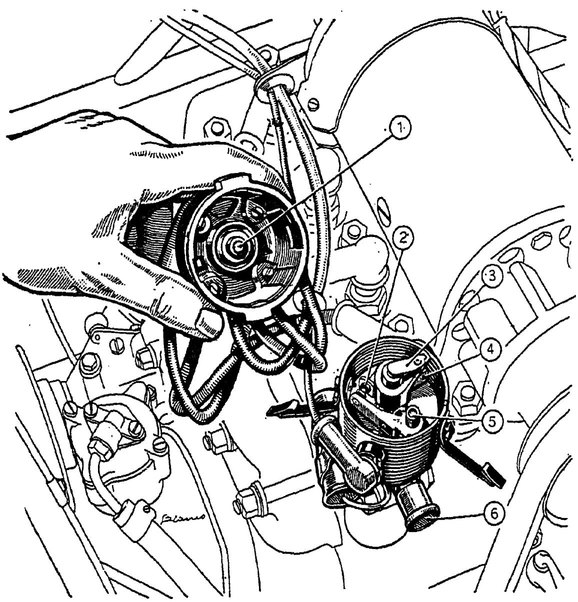


Fig. 3.—IGNITION DISTRIBUTOR

1, Carbon button. 2, screws and locknut for adjusting gap between platinum points. 3, revolving brush in position for firing No. 4 cylinder. 4, cam lubrication wick. 5, lubrication wick for pivot pin of movable platinum point. 6, screw grease-cup.

Cylinder Head

The cylinder head should never be removed when hot. Always wait until it has cooled down, to avoid possible distortion.

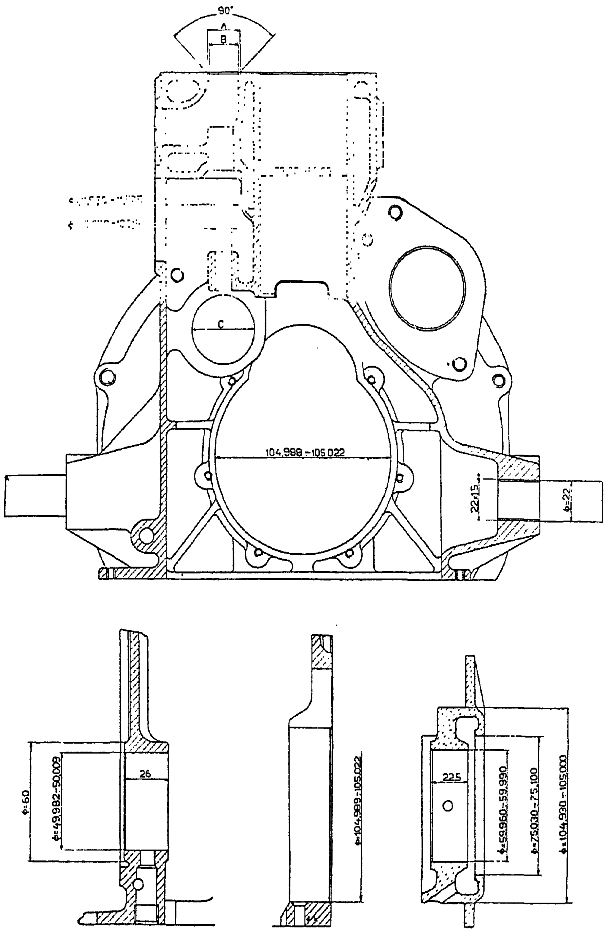
For checking the capacity of the combustion chambers, the cylinder head must be refitted, the piston brought to top dead centre, and the valves closed. Then pour through the sparking-plug hole a mixture of castor oil containing benzol to the ratio of 20 per cent., and use a graduated vessel. The liquid should reach the same level in each cylinder.

Crankshaft and Crankshaft Bearings

In order to dismantle the crankshaft and its bearings proceed as for dismantling the engine assembly.

The crankshaft is supported only at its ends, by means of two circular sleeve bearings. In order to ensure perfect working efficiency of the engine, it is most important that the crankshaft pins are exactly aligned. The crankshaft journal regrinding may be carried out with a circular grinding machine, bearing in mind that for the connecting-rod pins a hand-operated tool, fitted with a blade of 28 mm. in width, is quite suitable.

The clearance between the main bearings and the main journals of the crankshaft should be as small as possible. If it is found that this clearance exceeds ·004 in., it is advisable to replace the bearings altogether, refacing the pins if they are out of round. The bearings must be perfectly aligned. To achieve this result it is advisable to reface them to the exact diameter.



(A) Inlet 21·5 mm., exhaust 20 mm.

(B) Inlet 19 mm., exhaust 17·5 mm.

(C) Front bearing 40–40·025 mm., intermediate bearing 36·93–36·965 mm. rear bearing 24·94–24·97 mm.

4.—PRINCIPAL DATA CONCERNING THE CYLINDER BLOCK

The oil passages should be most carefully cleaned. If necessary dismantle the lubrication pipes conveying the oil to the connecting-rod pins. When reassembling them, carefully connect the terminal unions to the crankshaft bearing, in order to prevent them becoming loose when the engine is running, thus causing overheating and running of the metal.

Fig. 5 shows the principal structural data for the crankshaft and main bearings. On the basis of the standard constructional tolerances it will be easy to adapt oversize replacement parts in order to obtain a fitting in accordance with the original standard clearances.

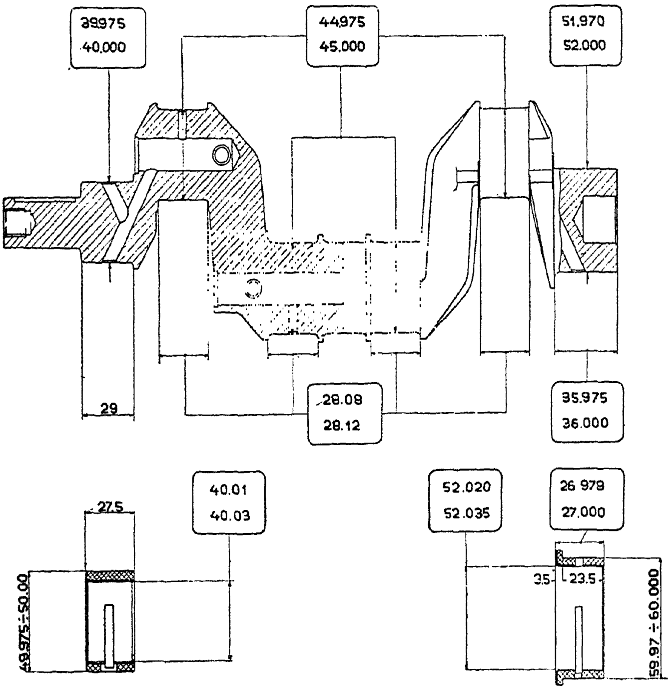


Fig. 5.—Crankshaft and main bearings

Oversizes for main bearings—·2 mm., ·4 mm., ·6 mm., ·8 mm., 1 mm., 1·5 mm., 2 mm.

CONNECTING RODS AND PISTONS

To dismantle connecting rods and pistons, first remove the oil sump and the cylinder head. The pistons of Nos. 1, 2, and 3 cylinders can then be removed from below. The piston of No. 4 cylinder must be withdrawn from above by removing the gudgeon pin.

To recut the gudgeon-pin hole in the piston, use an expanding reamer 15 mm. in diameter.

Valve Gear

The clearance between valve stems and their guides should not exceed ·006 in.

The allowable clearance between the tappet and the guide is about ·006 in.

Camshaft and Bearings

The camshaft should be perfectly aligned, and the clearance at the bearings should not exceed ·006 in. (·15 mm.).

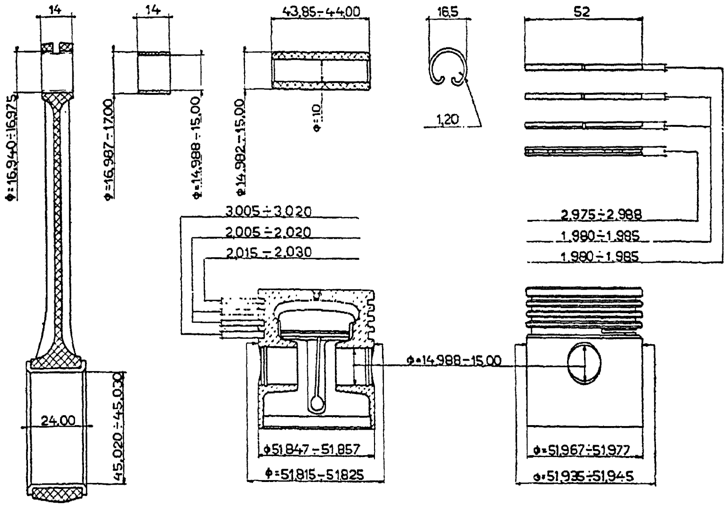


Fig. 6.—CONNECTING ROD, GUDGEON PIN, PISTON, AND PISTON RINGS SHOWN ACCORDING TO THEIR ASSEMBLING ORDER

The data for piston clearance are the nominal ones for pistons marked with the letter A; whereas those stamped with B and C correspond to ·01 mm. (·0004 in.) and ·02 mm. (·0008 in.) oversize dimensions. Starting from the engine No. 001204 the diameter of the piston was reduced by ·01 mm. (·0004 in.).

Range of oversize spare parts: Connecting rod, ·20, ·40, ·60, ·80, 1, 1·5, 2 mm.; gudgeon pin, ·20, ·50 mm.; piston, ·10, ·20, ·40, ·60, ·80, 1 mm.; piston ring, ·10, ·20, ·40, ·60, ·80, 1 mm.

Driving Shaft for Oil Pump and Ignition Distributor

The driving shaft for the oil pump and the ignition distributor is carried in a bronze bush. To avoid undue noise and wear, make sure that the play between this bush and the shaft does not exceed ·006 in. In addition, do not fail to ascertain that the driving shaft and the vertical one operating the ignition distributor are aligned, and that the joints, too, are in perfect condition.

Lubrication

From engine No. 019250, lubrication is forced by means of a gear pump driven by the camshaft and fitted with a suction filter submerged in the sump. On the crankshaft rear bearing is fitted the pressure-release valve. A delivery filter is located on the right side of the sump, easily demountable for cleaning, and fitted with a union on top for connection to the oil-pressure gauge. Normal pressure, 35 lb. per square inch.

Up to engine No. 019250, the engine lubrication is forced by means of a vane pump instead of a gear pump. In addition, the crankshaft front bearing is provided with an oil-discharge jet (drilled in the centring bolt

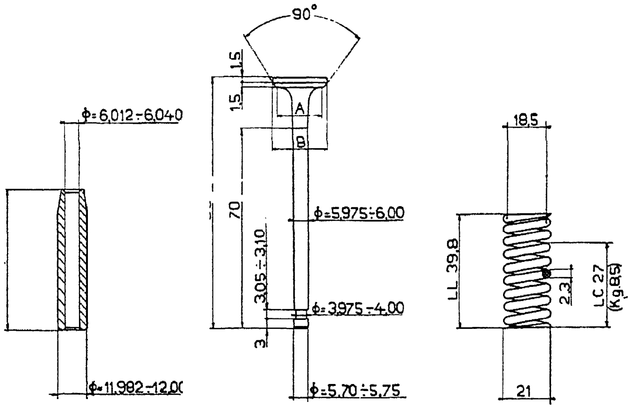


Fig. 7.—SHOWING MAIN DATA ON VALVES, VALVE GUIDES, AND VALVE SPRINGS

Inlet valve, A 19 mm., B 22 mm. Exhaust valve, A 17·5 mm., B 20·5 mm. Load for the spring compressed down to 27 mm. ($1\frac{1}{16}$ in.) is 8·5 Kg. (18·7 lb.).

of the engine front bearing), instead of a pressure-release valve. Initial speed of the engine should not be such as to show a higher pressure than 70 lb. per square inch on the oil gauge. The standard oil pressure is 35 lb. per square inch when the engine is warm.

The inner surface of the vane-pump body, against which the scoops slide, must be perfectly smooth, also the surface of the scoops working

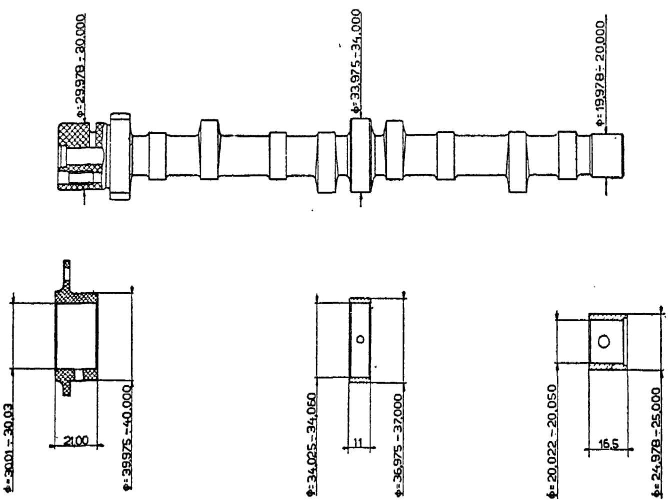


Fig. 8.—THE CAMSHAFT AND ITS BEARINGS

against the body of the pump and in the slot at the bottom of the shaft. Should there be ascertained between the scoops and the slot a side play exceeding ·006 in., replace all the parts that are worn. The pump shaft should have no play at all in its bearing through the pump body. Care should be taken that neither the pump-springs tension nor the diameter of the oil-discharge vent ever vary.

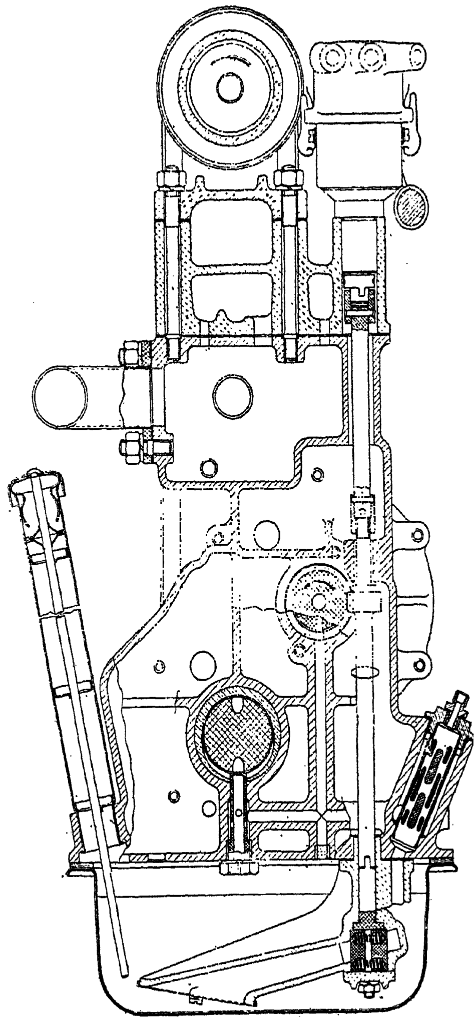


Fig. 9.—Cross-section of the engine, showing oil pump and distributor driving shaft

A vane-type oil pump is shown, as used on engines prior to No. 019250.

Carburettor (Solex 22 HD)

Choke diameter	14	mm.
Main jet .	0·80	,,
Auxiliary jet .	0·35	,,
Starting jet .	1	,,

The slow running of the engine is adjusted by means of a screw (1) (Fig. 11) which limits the closing of the carburettor throttle. Another screw (2) serves to vary the richness of the mixture. Consequently, slow running will be regular only at one particular setting of this screw. To regulate the running of the engine at slow speeds, the minimum speed must first be regulated by means of the screw (1), leaving screw (2) loosened off about three turns. Afterwards screw gradually up screw (2) until the engine turns over regularly.

If, during ordinary service, the engine shows a tendency to stop when the accelerator is released, screw (1) should be screwed up so as to increase somewhat the minimum speed, the mixture also being regulated by means of screw (2).

Should it be necessary to take the carburettor off the engine, in order to draw it off the studs on the inlet manifold, the right-hand front wheel must be turned outwards, and the cover, secured by three screws to the side of the body, removed.

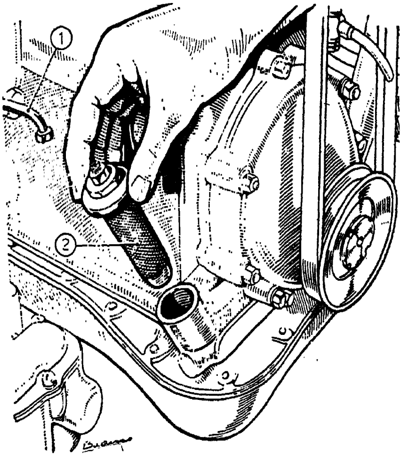


Fig. 10.—ENGINE OIL FILTER

1, Oil-delivery pipe to pressure gauge ; , filter gauze.

CLUTCH

The clutch pedal should be adjusted in such a way as to leave from ½-in. to ¾-in. free travel before operating the clutch. When the clutch linings have become worn to such an extent that the free travel is reduced or eliminated —in which case the clutch will tend to slip—the pull-rod controlling the horizontal clutch lever must be slackened off and locked in the new position by means of the locknuts provided.

If, by slackening the pull-rod, the necessary adjustment is not obtained, this shows that the clutch facings are worn out and must be renewed.

In such a case it is necessary to again balance the driven plate. The plate may be balanced by reducing weight on the heavier side by grinding and scraping the outer edge.

Inspect the clearance between the splines on the driven-plate hub and those on the direct-drive shaft. This clearance should not exceed ·008 in., so as to prevent the clutch-driven plate from any tendency to rattle. See that the driven plate runs perfectly true.

Make sure that the bolts fixing the clutch plate to the engine flywheel are in a satisfactory con-

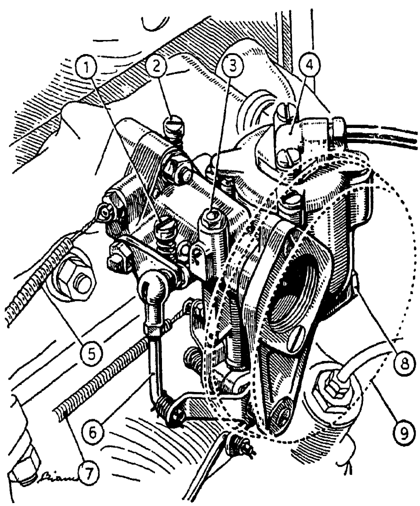


Fig. 11.—SOLEX CARBURETTOR (WITHOUT AIR-INTAKE SILENCER)

1, Idling speed regulating screw; 2, idling speed air-intake regulating screw; 3, pilot screw; 4, petrol-inlet union; 5, starter control; 6, throttle control; 7, economiser control; 8, screw carrying main jet; 9, air-intake silencer (removed).

dition. If they are found to be worn they should be replaced. In order to replace these bolts the engine flywheel must be removed from the crankshaft, because the fixing nuts of the bolts must be unscrewed from the inside.

The assembling and adjustment of the clutch may be rendered much easier if the specially designed tool A. 10112 is used. This tool is provided with two distance-rings, corresponding to the respective positions of the levers when the driven plate has both new or worn linings.

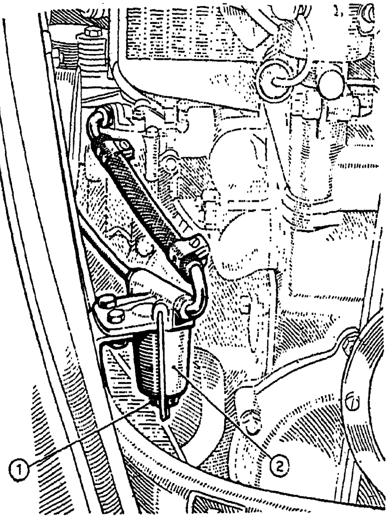


Fig. 12.—PETROL FILTER

To reach the petrol filter for cleaning, close tap under petrol tank and take down filter chamber (2) by unscrewing knob (1).

GEARBOX

Dismantling the Assembly

Remove the engine from the car, together with the clutch and gearbox, and then remove the gearbox from the engine.

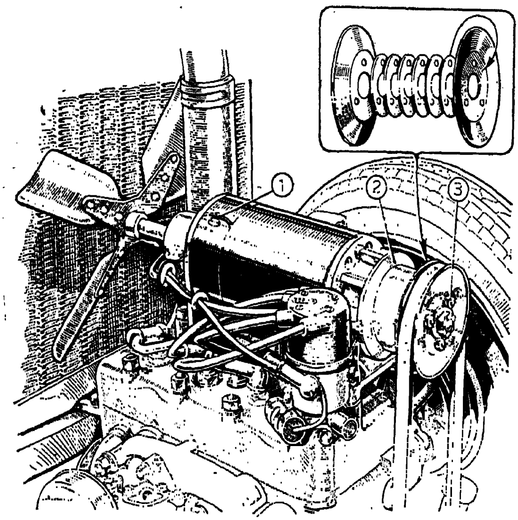


Fig. 13.—CURE FOR SLACK DYNAMO AND FAN BELT

Unscrew the three pulley-securing nuts (3). The pulley can then be dismantled as shown in the picture at the top. Bring one or two of the rings (according to the degree of slackness of the belt) to the outside of the pulley shown by the arrow and reassemble. 1 shows band to be removed to gain access to dynamo commutator. 2, vaned rotor for cooling dynamo.

Remove the gearbox cover; the side cover and the bush for the reverse-gear safety pawl; the sleeve (*M*) for the speedometer cable; the transmission joint; the spherical nut fixing the brake drum to the transmission shaft. Then remove the drum; the rear cover together with the transmission-shaft brake band; the two screws retaining the ball housing of the gear-lever articulation.

Tighten the gear lever

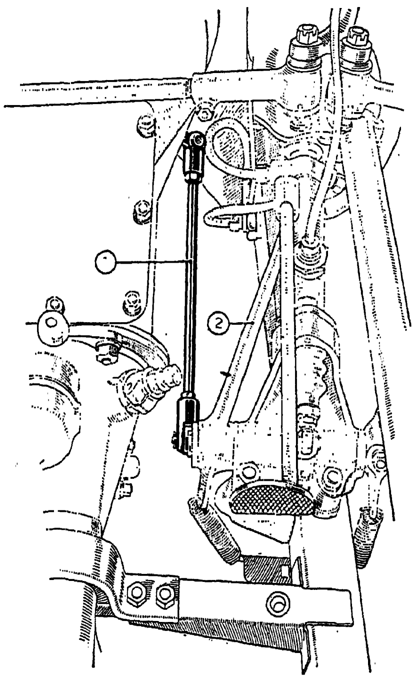


Fig. 14.—ADJUSTING CLUTCH

To adjust free travel of clutch pedal, unscrew pull-rod until there is $\frac{1}{2}$ to $\frac{3}{4}$ in. play and then lock in new position by means of locknuts provided; 2 is the clutch-actuating rod.

provisionally, pushing it in the neutral position. The engaging slots of the striker rods should be placed so that the rear cover can be removed, as follows: Lift the gear lever upwards and to the left until it is possible to disengage it together with the rear cover, after removing the fixing nuts on the gearbox.

Pull off the rear cover from the primary shaft. Remove the three side plugs with sphere locks, and the striker rods, after having straightened the locking plates and removed the bolts which fix the fork levers.

Pull out the primary-shaft rear ball bearing; and the washer and the spring ring. Unscrew, by means of a wrench (A. 8066), the locking ring on the primary shaft, after having straightened out the locking plate. Then pull out the speedometer driving pinion, taking care of the tiny locking key. Pull out also the locking ring.

Remove the plate retaining both the primary-shaft bearing and the reverse-gear pin. Dismantle the support of the clutch-release control fork. Remove the front cover.

Unscrew by means of a wrench the locking rings of the secondary shaft, straightening out the lock plates. Push out the direct-drive gears, striking with a lead hammer on the connection with the primary shaft. The secondary-shaft gear should also be pushed a little outwards. The spring ring can then be removed from its seat in the outer ring of the direct-drive shaft ball bearing.

Push back the direct-drive and primary-shaft gears, then the secondary-shaft gears, using a lead hammer against the direct-drive and secondary shaft, until the primary- and secondary-shaft rear ball bearings have come out from their housings. Pull out the rear ball bearings of the primary and secondary shaft. Remove the secondary-shaft front ball bearing, dropping the corresponding gears in the bottom of the gearbox.

Take off the gears of the direct drive. Remove the third- and top-gear

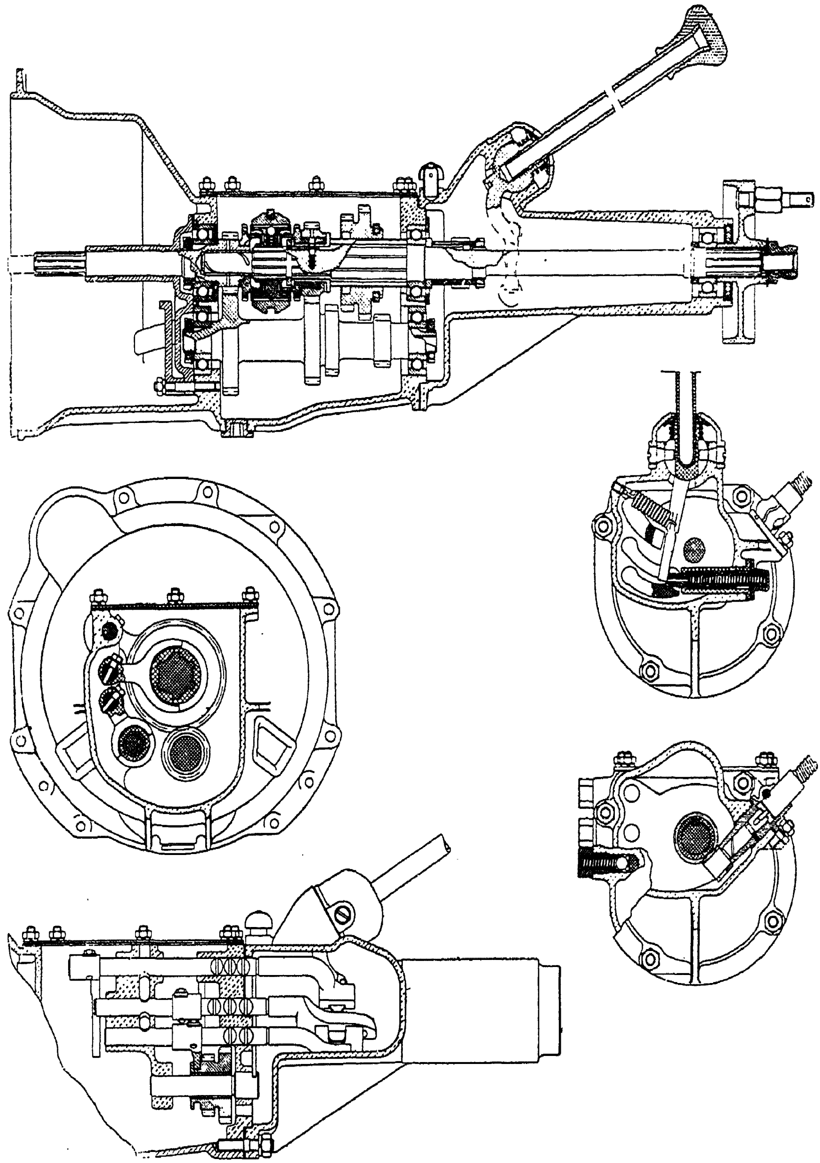


Fig. 15.—SECTIONS OF THE GEARBOX

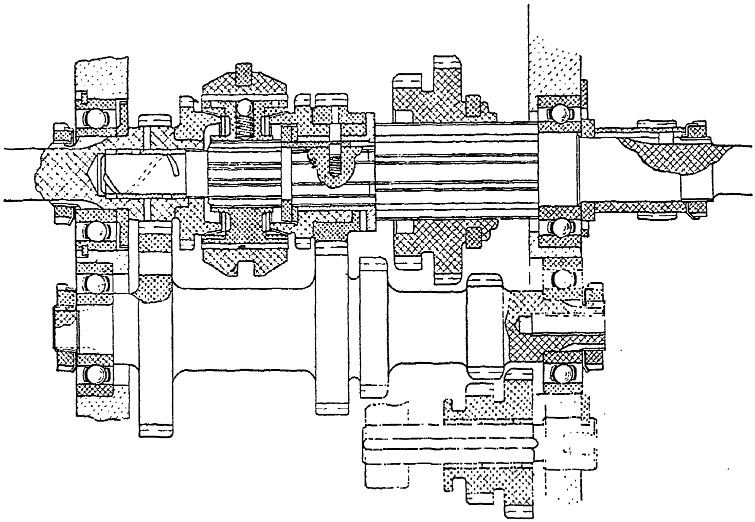


Fig. 16.—SECTION OF GEARBOX THROUGH THE THREE SHAFTS

engaging sleeve, pulling out the primary shaft and its gears from the bottom towards the upper side of the gearbox. Remove the secondary-shaft assembly in the same manner.

Pull out the reverse-gear pin, removing the gears from the interior of the gearbox. Dismantle the direct-drive assembly, loosening the locking ring by means of a wrench, and dismantle the synchronising device and the third-speed gears from the primary shaft.

To assemble, repeat the operations in reverse order.

HUDSON AND TERRAPLANE ENGINES

THE engines used in all Hudsons and Terraplanes are of the vertical-in-line type.

Vibration Damper

The vibration damper consists of a hub keyed to the crankshaft, and a flywheel which is driven from the hub through two rubber discs. It requires no service unless the rubber deteriorates, and then the rubber should be replaced. Keep the rubber free from oil. To remove the damper, first remove the radiator core and shell. The crankshaft starting jaw is then removed and the damper pulled off.

Removal of Crankshaft

After the vibration damper has been removed, take off the timing-gear cover. The leather seal around the opening in the cover should be inspected to see that it is in good condition, and care should be taken in replacing the cover not to damage or fold the edge of the seal when it is placed over the vibration-damper spacer. The crankshaft gear is next removed.

The oil sump, gearbox, and clutch must be removed, and the connecting rods disconnected from the crankshaft if the shaft is to be removed from the engine. If inspection or adjustment only is required it is only necessary to remove the oil sump.

Crankshaft-bearing Caps

The lower halves of the crankshaft bearings are each held in place by two studs and nuts. The front and rear caps enter machined openings in the crankcase, so that they are flush with the bottom of the case.

It is necessary to use a puller to remove the front and rear bearing caps, as sufficient force must be applied to shear the packing in the horizontal groove. After the cap is removed the packing should be thoroughly cleaned from the grooves in the case and cap. None of the packing should be allowed to remain in the case as it may clog oil passages.

After the bearing caps have been replaced and the stud nuts tightened and keyed the packing should be replaced. Drive cotton wicking into the front bearing-cap horizontal hole first, then drive into the vertical holes of both the front and rear bearing caps.

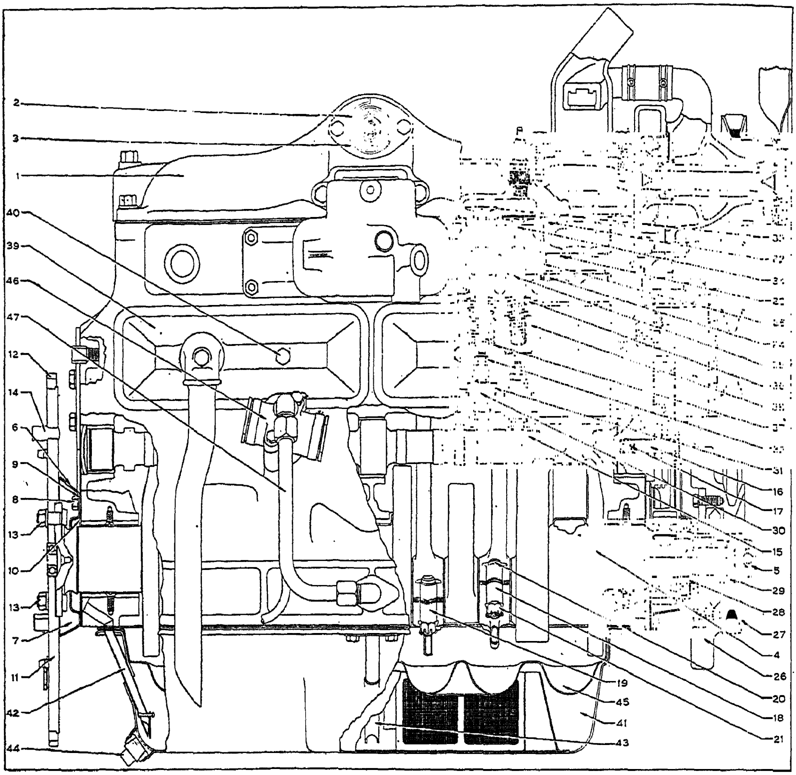


Fig. 1.—SECTION OF TERRAPLANE ENGINE

1—Exhaust Manifold
2—Exhaust Damper Thermostat
3—Exhaust Damper Cover
4—Crankshaft
5—Crankshaft Starting Jaw
6—Crankshaft Oil Throw—Upper
7—Crankshaft Oil Throw—Lower
8—Crankshaft Oil Throw Bolt
9—Crankshaft Oil Throw Gasket
10—Rear Main Bearing
11—Flywheel
12—Flywheel Gear
13—Flywheel Bolt
14—Clutch Driving Lug
15—Camshaft
16—Camshaft Thrust Button
17—Camshaft Thrust Button Spring
18—Connecting Rod Assembly—R. H.
19—Connecting Rod Assembly—L. H.
20—Connecting Rod Bolt
21—Connecting Rod Bolt Nut
22—Piston
23—Gudgeon Pin
24—Piston Ring
25—Gudgeon Pin Lock Ring
27—Vibration Damper
28—Damper Spacer
29—Vibration Damper Hub
30—Tappet
31—Tappet Guide
32—Tappet Adjusting Screw
33—Intake Valve
34—Exhaust Valve
35—Valve Guide
36—Valve Spring
37—Valve Spring Seat
38—Valve Spring Damper
39—Valve Chamber Cover
40—Valve Chamber Cover Bolt
41—Oil Sump
42—Rear Main-bearing Oil-return Tube
43—Oil Suction Pipe
44—Oil Sump Drain Plug
45—Oil Dipper Tray
46—Oil Pump
47—Oil Suction Pipe

Main Bearings

The lower halves of the main bearings are secured in the caps with screws, while the upper halves of the bearings are secured in the case.

Bearing adjustments can be made by removing the bearing caps and removing shims from the pack on top of the bearing cap.

The main bearings should have ·001-in. clearance and not more than ·012-in. end play, the latter being checked at the centre main-bearing flange in the six-cylinder engine, and the No. 3 main-bearing flange in the eight-cylinder engine.

Main bearings are available finished to standard size or unfinished. The finished bearings can be put in place in the case and secured with the screws, and adjusted to proper clearance by selection of shims.

When new bearings are being fitted to a badly worn or reground shaft the unfinished bearings should be put in place in the case and cap, the caps installed in the case with ·021 in. of shims and line reamed to size.

In this case, the main bearing with the thrust flange must also be faced to allow ·006-in. end play.

Oil Sump

The oil sump is of pressed steel, and incorporates cooling baffles and oil screens to cool the oil and remove foreign particles before it is re-circulated. The dip-trough tray is an entirely separate part and is assembled into the sump with a gasket between the flanges of the two parts. A similar gasket is installed on top of the dip-trough tray to form a seal with the crankcase lower flange.

The rear main-bearing oil-return tube (Fig. 1) is soldered in the rear of the sump and registers with the rear main-bearing drain hole. Be sure the gaskets used between the sump and dip-trough tray and also between the tray and crankcase have holes in line with the drain tube. If these holes are not open, oil will be lost out of the rear main-bearing oil slinger (6) and (7), Fig. 1.

A flapper valve is located on the bottom of the oil-return tube to prevent oil from being thrown up the tube and out of the rear main bearing. When the reservoir is setting level, this valve should be slightly open. Check the valve plate to see that it moves freely against the end of the tube.

Rear Main-bearing Oil Retainer

After the rear main-bearing cap has been removed and reinstalled, the lower half of the oil retainer (7) should be checked to see that it fits tightly against the upper half, and also to see that the gaskets are in good condition. A gap between the two halves of the retainer will permit loss of oil.

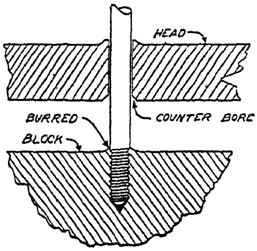


Fig. 2.—BURR ON CYLINDER BLOCK

Cylinder Head

Before the cylinder head can be removed from the 1934 or 1935 models it is necessary to remove the upper hose connections and fan belt, or to remove the three cap screws which attach the water pump to the cylinder head.

Lugs are cast along the left side of the cylinder head and cylinder block to permit the use of a pinch-bar to lift the cylinder head away from the gasket after the cylinder-head stud nuts have been removed.

The seal can usually be broken, however, by cranking the engine with the starter. Be sure the spark-plug wires are removed and the ignition is off before this is attempted. One stud nut should also be left on loosely both at the front and rear to prevent the head being lifted completely off.

In rare cases, it may be necessary to pull the head off by means of a chain hoist and two eye bolts screwed into spark-plug holes. If necessary to strike the head with a hammer in order to ease it off the studs, use only a rawhide hammer.

Be sure that the surfaces of both head and block are in good condition and free from particles of dirt and carbon. If trouble is suspected, check each surface with a long straight-edge.

A condition which may be encountered in cars which have seen considerable service is shown in Fig. 2. It will be noted that the stud has thrown up a burr around the top of the threaded portion. When this happens, it is plain that the gasket will be pinched tightly at this point, but that there will be little pressure on the gasket over its wider area. The remedy for this condition is to slightly counterbore the stud holes in the head, as indicated in the picture.

A light coating of gasket seal should be applied to both faces of a new gasket. This should be cleaned off carefully around the edges so that none gets into the cylinder. Install gasket on the block so that the letters on the gasket are uppermost.

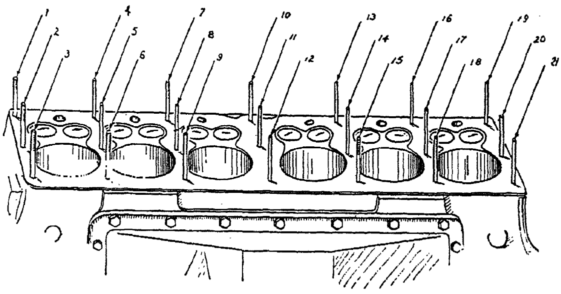
After the cylinder head has been set down on the gasket, put on all the stud nuts and turn them down finger tight. Then tighten the nuts very carefully, each a little at a time, so that one particular nut never gets excessive tension.

The following plan has proved most satisfactory. This explanation applies to the twenty-one nuts of the Terraplane six-cylinder engine ; and the same system can be used on the thirty nuts of the eight-cylinder engine.

Start with middle nut, No. 11 in Fig. 3. Pull nut down until it is just snug—or just starts to take hold. Pull down in sequences, 11-8-5-2-14-17-20, just snug. Go back to No. 11, and pull down fairly tight, 11-10-12-8-7-9-14-13-15-5-4-6-17-16-18-2-1-3-20-19-21. Go back to No. 11, and in

the same order as before, 11-10-12-8-7-9, etc., pull all nuts down tight.

Run the engine to warm up, and while warm, tighten nuts again in the same order.



. 3.—CYLINDER-HEAD STUDS

Pistons

The pistons are made of aluminium-silicon alloy. The piston skirt is cam ground and tapered. The piston rings are pinned to prevent rotation in the grooves, so that they wear-in to the cylinder contour and remain in a fixed position to maintain a better oil seal.

When replacing gudgeon pins, select the pin so that it can be pushed into the piston boss with the heel of the hand when the piston is heated to 200° Fahrenheit. Heat the piston in boiling water or in an electric furnace. Heating with a blow torch or other concentrated heat, or driving the pin in or out of the bosses, will distort the piston.

After the proper-sized pin is selected, replace the connecting-rod upper bushing and ream or burnish to ·0003 in. larger than the pin. If this fit is correct the connecting rod will just turn on the pin under its own weight when the rod is held in a horizontal position.

Whenever a connecting rod is removed from the engine it should be checked for alignment. When bending connecting rods in order to correct misalignment, always bend beyond the straight position and bend back to straight to relieve strains set up by bending, or the rod will not remain straight after it is fitted in the engine.

Connecting-rod and Piston Removal

The connecting-rod and piston assemblies are removable by taking off the oil sump and cylinder head. The connecting-rod caps are then removed and the rod and piston assemblies removed from the top of the cylinder.

Connecting-rod Bearings

Up to 1938, the connecting-rod bearings are adjustable by removing shims from between the rod and bearing cap. They should be adjusted to ·001-in. clearance.

Important: If a rod bearing is burnt out, the oil troughs in the crankcase walls and webs leading to the main and camshaft bearings must be thoroughly cleaned of white metal which may have been thrown into them.

Selecting and Fitting Piston Rings

When fitting the pinned-type piston ring, the gap between the ends of the ring and the clearance between the pin and the ends of the ring are equally important.

The rings are cut and notched to accept the pin so that the clearance on the pin is equal to the gap between the ends of the ring (Fig. 4). In other words, if the ring is compressed so that the ends come together there will be no clearance on the pin.

If the ends of the ring are filed in fitting the ring it is necessary to file an equal amount in the pin notch to maintain the pin clearance. Filing, however, should not be necessary.

Piston rings of the pinned type are supplied in exact sizes to give a minimum gap of ·005 in. when installed in a cylinder of the size for which the ring is designated. Since it is necessary to hone or otherwise recondition a cylinder bore when oversized pistons are being fitted, they should be brought to an exact size for which piston rings are available. For example, a cylinder may clean up at ·009 in. oversize. However, since no ring is available in this size it is advisable to hone the cylinder to ·010 in. oversize rather than file the gap of a set of ·010-in.-oversize rings to permit their use in a ·009-in.-oversize cylinder.

The sizes in which piston rings are available are given on page 391. When ordering rings, both the part number and the size desired should be given on the order.

Selection of Pistons

The code letters stamped on the cylinder block along the lower face of the valve chamber designate the original size of each cylinder. The size code letters and piston weight, in ounces and quarter-ounces, stamped on the heads of the pistons, will help in selecting pistons correctly from stock. In addition to the size and weight marks all original piston installations are numbered to indicate the cylinder-block number and the number of the cylinder in which the piston is fitted.

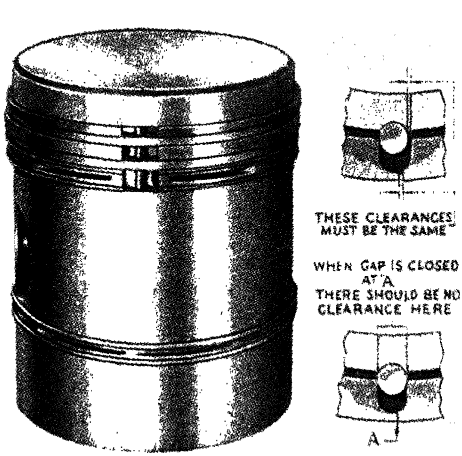


Fig. 4.—PISTON-RING CLEARANCES

Where a single piston is selected it should be of the same weight as the piston removed. Complete sets of new pistons should always

carry the same weight stamp on all pistons. Unequal piston weight will cause rough engine operation.

After selecting a piston by the code letters, place it in the cylinder in which it is to be used with a ·0015-in. feeler directly opposite the skirt slot. The position of the feeler is important, due to the cam grinding of the skirt. If the piston is the correct size, the feeler can be removed by exerting from 3 to 4 lb. pull.

The following table gives the cylinder-bore sizes from standard to ·020-in. oversize for which pistons are available. Opposite each cylinder size is given the cylinder code (if any), the code letter of the correct piston size, and the piston-ring size.

It will be noted that the same ring size may be designated for more than one piston size. It is advisable to hone the cylinder to the smallest dimension for which a given ring is recommended. This gives a minimum piston-ring gap. Always check rings to see that the gap is not less than ·005 in.

PISTON AND RING FITTING TABLE

Cylinder		*Piston*	*Piston Ring*
Size	*Code*	*Code*	*Size*
3·000	A	B	3·000
3·0005	B	B	3·000
3·001	C	D	3·000
3·0015	D	D	3·000
3·002	E	F	3·000
3·0025		F	3·000
3·004		J	3·003
3·005		L	3·005
3·010	AO	BO	3·010
3·0105	BO	BO	3·010
3·011	CO	DO	3·010
3·0115	DO	DO	3·010
3·012	EO	FO	3·010
3·0125		FO	3·010
3·015		LO	3·015
3·020		BB	3·020
3·021		DD	3·020
3·022		FF	3·020

Fitting Pistons

When checking piston size by the feeler-gauge method, take the following precautions :

(1) Remove ridge from top of cylinder with a ridge reamer.

(2) Place feeler gauge in extreme right of cylinder.

(3) Insert piston with wrist-pin bosses parallel to crankshaft and unslotted side of skirt to right.

(4) Be sure feeler gauge contacts piston 90° from centre-line of piston-pin bosses.

(5) Measure pull required to remove feeler gauge with spring scale. Don't guess—a thousandth of an inch variation will change the pull on the feeler only a few pounds.

Camshaft

Spiral gears are machined into the camshaft to drive the oil pump and distributor and also an eccentric to drive the fuel pump.

The timing gears are helical, and cut so that the thrust of the drive is taken against a thrust-washer placed between the front face of the crankcase and the rear of the front flange of the camshaft.

A plunger (16, Fig. 1) mounted into the front end of the camshaft is pressed forward by a spring against a hardened plate in the timing-gear cover, to keep the camshaft from floating forward.

The camshaft can be removed by blocking the tappets up to their highest normal travel, after the timing-gear cover has been removed.

The camshaft bearings are replaceable, although this is an operation seldom needed during the entire life of the car. If bearings are replaced they should be line reamed to ·001-in. clearance.

Tappets

The tappets are of the roller-shoe type and are replaceable singly or in assembly with the replaceable tappet guides.

The tappet and guide assemblies can be removed without removing the cylinder head, as follows :

(1) Remove the tappet-chamber cover from the right side of the engine.

(2) Remove the valve-spring seat-retainer spring seats, spring dampener and spring.

(3) Remove the tappet adjusting screw and replace by a short screw with a thin head.

(4) Remove the tappet-guide clamp screw and clamp.

(5) The tappet and guide assembly can then be lifted out.

This procedure is recommended where only a few of the tappets are to be replaced. If the complete set is to be replaced, time can be saved by removing the cylinder head and valves and then removing the tappet assemblies.

Valve Springs, Guides, and Seats

The valve springs are cadmium plated to prevent rusting. They should be tested for strength whenever they are removed. Valve springs which show a pressure of less than 34 lb. when compressed to 2 in. should be replaced. New springs should show 44-lb. pressure at 2 in. and 102 lb. at $1\frac{21}{32}$ in.

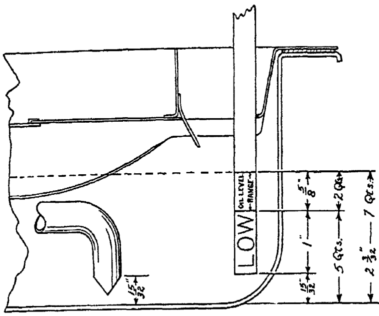


Fig. 5.—HUDSON 8 OIL SUMP

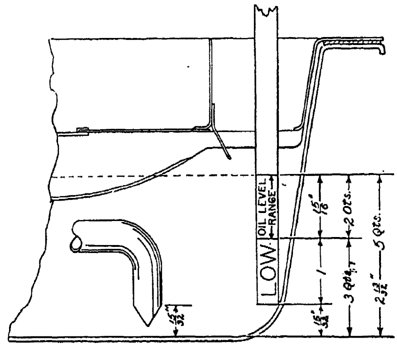


Fig. 6.—TERRAPLANE AND HUDSON 6 SUMP

When replacing valve guides drive them so that the top in the six-cylinder engine is $1\frac{1}{16}$ in. below the top of the cylinder block, and in the eight-cylinder engine, $\frac{15}{16}$ in. After the guides are replaced they should be reamed to ·002 in. larger than the valve stem.

The valve seats should be refaced with a 45° cutting tool. Because of the hard glaze which develops on the valve seats a piece of emery cloth should be placed over the cutter pilot and used to remove the glaze from the seat. The cutter can then be used without chattering. This also increases the life of the cutter.

Valve Timing

The valve timing is determined by the mesh of the timing gears. The crankshaft gear is keyed to the crankshaft and can be installed in only one position. The camshaft gear fits over the flange of the camshaft and is secured by three cap screws. These cap screws are unequally spaced so that the cam gear can be located in only one position. Correct timing is obtained by meshing the punch-marked tooth of the crankshaft gear between the two punch-marked teeth of the camshaft gear.

Valve-tappet Adjustment

The valve tappets should be adjusted to a clearance of ·006 in. on the intake and ·008 in. on the exhaust when the engine is at normal operating temperature.

The valve locations, counting from the front of the engine, are as follows :

Six-cylinder { Intake—2-4-5-8-9-11
Exhaust—1-3-6-7-10-12

Eight-cylinder { Intake—2-3-6-7-10-11-14-15
Exhaust—1-4-5-8-9-12-13-16

Engine Lubrication

The Hudson Duo-Flo system of lubrication is very simple and positive. The double-acting piston and drive shaft are the only moving parts, and these move at only $\frac{1}{12}$ engine speed, ensuring low wear and long life.

Oil Pump

The pump can be removed by disconnecting the inlet and outlet lines and removing the two mounting-cap screws.

To disassemble the pump, remove end hexagon caps and gaskets, and dowel screw from pump mounting sleeve. Withdraw shaft and plunger.

Before reassembling wash all parts thoroughly, blow dry, and dip the shaft and plunger in engine oil.

The inlet to the pump consists of two $\frac{5}{8}$-in. tubes. The first leads from the sump to the crankcase side wall, and the second from the crankcase side wall to the pump. It is important in checking the system to see that the lower suction line extends to within $\frac{15}{32}$ in. of the bottom of the sump, as shown in Figs. 5 and 6, and that both the sump and tray gasket are in good condition. Also that the connection at the cylinder block and the one at the oil pump are tight. Leakage at these points will cause air to be sucked into the system, and oil flow will be reduced if not stopped.

Oil-delivery Lines

There are two $\frac{5}{16}$-in. oil lines from the pump. One leads from the upper pumping chamber to the timing-gear compartment, and the other from the lower pumping chamber to the oil check valve at the rear of the engine where the oil enters directly into the top trough of the rear cylinder.

Oil Check Valve and Signal

The purpose of the oil check valve is simply to build up enough pressure to operate the dash signal to indicate oil flow.

The valve consists of a housing in which a piston operates against spring pressure. When there is no oil flowing and consequently no pressure the piston is pushed down against an insulated pin, which is the "ground" for the dash-signal light. The light will burn until sufficient pressure is developed to raise the piston. A bleed-hole is provided in the piston to allow a small quantity of oil to pass by the piston to the outlet. This hole must be kept clean, or the light will not come on immediately when the oil flow stops.

From the above, it will be gathered that the oil from the pump flows to both the front and rear of the engine. The flow to the troughs cast into the walls of the cylinder block which feed the main and camshaft bearings is caused by the action of the connecting-rod dippers in the oil in the dip troughs, and is accurately controlled by baffles in the dip-trough tray. The oil is circulated progressively from the ends of the engine to the return opening at the right centre, where it is returned to the sump

and diverted by baffles along the cool outside walls of the sump for cooling before it passes through the filter screens to be re-circulated.

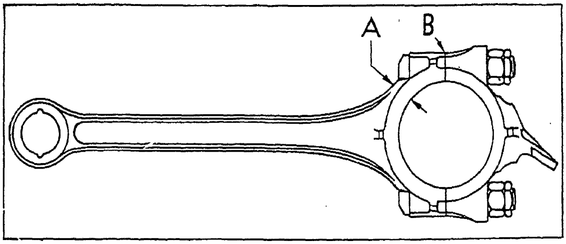


Fig. 7.—CONNECTING-ROD ASSEMBLY (1938)

Fan-belt Adjustment

The fan belt is adjusted by swinging the generator on its mounting. Since the fan belt is of the " V " type, it does not require tension to prevent slippage. A slight amount of slack must be allowed to prevent an overload on the water pump and generator bearings.

To adjust :

(1) Loosen generator bracket-bolt nut and adjusting-arm nut.

(2) Pull generator away from engine until the slack in the belt is such that the section between the water-pump pulley and the generator pulley can be pushed down 1 in. below a straight-edge laid across these pulleys.

(3) Tighten adjusting-arm bolt nut and generator mounting-bracket nut.

SERVICE PROCEDURE FOR 1938 ENGINES

Connecting Rods

The connecting rods in 1938 Hudson and Hudson Terraplane engines have a much heavier section immediately above the crankshaft bearing (*A*, Fig. 7). This extra rigidity gives a more even bearing pressure. Connecting-rod bolts are ground to close limits and fit in reamed holes in the new rods, thus providing a better cap alignment.

Connecting-rod Bearings

No shims are used in the 1938 construction.

Adjustment of connecting rods is not recommended. When a rod bearing becomes loose enough for adjustment the rod should be replaced.

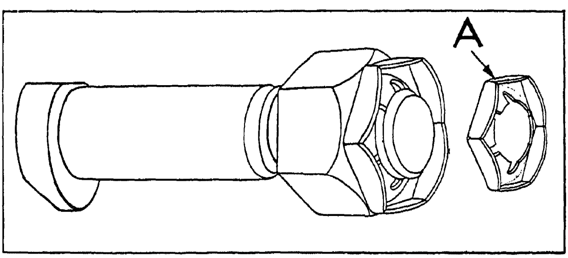


Fig. 8.—CONNECTING-ROD BOLT

Connecting-rod Bolt Lock

A light-weight palnut is used in place of the conventional cotter pin in

securing the connecting-rod bolt nut. This device (*A*, Fig. 8), is a small single-thread nut stamped from light-gauge steel and tempered. In application, it tightens down against a plain hexagon nut and locks itself in the bottom of the bolt thread by the compression of the single, conical-shaped thread.

Applying Palnut

Tighten the regular nut to desired tension. Spin palnut (smooth face to nut) on to bolt with fingers until it is snug against nut. Then tighten palnut with a wrench one-quarter to one-third turn more to lock it. This locks the conical-shaped single thread firmly into the root of the bolt thread.

The use of new palnuts is recommended.

1938 Valves

The stems of 1938 valves were reduced from $\frac{3}{8}$ in. to $\frac{11}{32}$ in. in order to reduce their weight. This lessens the inertia loads on the camshaft.

If Sudden Rise in Oil Consumption is Experienced

From 1937 onwards a combination fuel and vacuum booster pump has been used. A sudden rise in oil consumption of the engine may be traceable to this vacuum booster equipment. A punctured diaphragm in the vacuum booster section would cause oil to be drawn from the engine into the induction manifold. The remedy is a simple one—the renewal of the diaphragm in the vacuum booster pump, or, as a temporary expedient, the vacuum line from the pump to the induction manifold could be disconnected and the hole in the induction manifold plugged.

THE MORGAN 4/4 ENGINE, ~~CLUTCH,~~ AND GEARBOX

THE following notes relate to the 1936–9 Morgan car:

Number of cylinders	
Bore and stroke	63 × 90 mm.
Capacity, c.c. .	1122
R.A.C. rating .	9·8
Compression ratio	6·85
Firing order .	1, 3, 4, 2
Gear ratios—1st	17·1
2nd	12·1
3rd	7
Top	5
Reverse	22·6
Capacities—Sump .	8 pints
Gearbox	1½ pints
Radiator	2 galls.
Petrol tank	9 galls.

ENGINE

Removal from Chassis

Except for major overhauls, and for attention to the clutch, it should seldom be necessary to remove the engine from the chassis.

The most straightforward way is to remove engine, clutch housing, and gearbox as one unit. It will follow that, in order to allow the gearbox to clear as the unit is raised and at the same time "tilted," certain portions of the front woodwork will have to be removed. If the following procedure is carried out no difficulty will be experienced:

First remove the bonnet and disconnect all controls, water joints, petrol and oil pipes, etc., and remove radiator. Then remove the screws from woodwork carrying horn, coil, etc., and from pedal board. Remove gearbox holding-down bolts, bolts holding clutch housing to cross-member on which it rests, and bolts from front engine-bearer brackets. The complete unit is then ready to be raised with suitable lifting gear, and if gently "tilted" in the process everything will clear. Uncouple gearbox while engine is on the bench, and afterwards clutch housing.

Decarbonising

Before decarbonising have a complete set of joint washers and gaskets at hand. A good job is often spoilt by using old washers through lack of

foresight in not having new ones available. The following are almost invariably necessary after the origins have been disturbed:

Cylinder-head gasket.
Inlet rocker-cover washers (2).
Exhaust tappet washer.
Exhaust-manifold washers (3).
Induction-bracket washer.
Exhaust-pipe washer.
Water-outlet manifold washers (4).
Rocker-bracket base washers (2).

Reasonable precautions should be taken to prevent carbon flakes and dust from getting down the cylinder bores, through valve orifices or water-ways. Any such foreign matter finding its way into the oil in the sump may cause a falling-off in oil pressure through obstruction of the oil relief valve.

When replacing the cylinder head it is always worth while using a new gasket. It is sometimes possible to lift the head without damage to the gasket, in which case it can be used again. Make sure it lies perfectly flat, and apply a small quantity of good-quality jointing compound to each side of the gasket before replacing.

It is important that the cylinder-head nuts should be tightened down evenly, to avoid excessive pressure in one spot. They should be tightened down starting at the centre of the head, working outwards to front and rear, and at the same time diagonally. Go over all nuts again after the engine has been run and warmed up.

Tappets

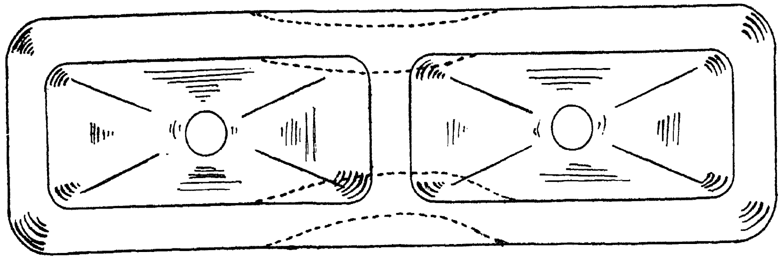
It should be noted that the inlet-valve tappet clearances cannot be checked until the push-rods, rockers, and rocker mountings have been replaced. Also the cylinder-head nuts should be finally tightened when the rocker mountings and induction pipe have been bolted home. The rocker covers should not be replaced until the engine has been run for at least ten minutes and the holding-down nuts retightened and tappets finally adjusted.

Tappets should be adjusted to the following clearances:

Inlet	·006 in.
Exhaust	·010 in.

Inlet-rocker and Exhaust-tappet Covers

Care should be taken in refitting the inlet-rocker and exhaust-tappet covers. Incorrect or careless fitting can result in leakage of oil, which, in addition to increasing consumption, smothers the engine and keeps it in a continual state of untidiness. All these covers have cork joint washers. It is essential that the holes in the rocker covers register with the dowel



g. 1.—SHOWING TENDENCY OF EXHAUST-VALVE COVER-JOINT WASHER TO SAG

in the cylinder head, and also that the holes in the joint washers fit over the dowels. No amount of tightening will prevent loss of oil if these precautions are not observed.

Exhaust-valve cover joints are very frequently the cause of trouble through careless fitting. The long joint washer has a tendency to sag in the middle when the cover is being replaced, so that a good joint is never possible. To allow the washer to follow the shape of the metal cover, therefore, it is a good plan to smear a small quantity of grease round the edge of the cover. This will obviate any possibility of the washer becoming misplaced when replacing and screwing up the cover.

Induction Pipe

There is a correct way to tighten the induction pipe which, if not rigidly adhered to, can result in damage to the pipe. Do not tighten down on to the exhaust manifold, but first tighten down the three nuts on the cylinder head. Then ascertain if the washer between the pipe and exhaust manifold is of requisite thickness before finally tightening. Pack, if necessary, to prevent strain being imposed.

Contact Breaker

After cleaning the distributor, check contact-breaker points and adjust so that when fully separated they are ·012–·015 in. apart.

Sparking Plugs

Readjust sparking-plug gaps to ·022–·025 in.

If, after decarbonising and running, any falling-off of pressure is noticed, the relief valve should be removed and thoroughly cleaned.

Decarbonising, including removal of pistons, is quite conveniently carried out with the engine in position.

Oil Pressure

Observe that the oil pressure does not fall below 40 lb. per square inch. If any falling-off in pressure is noticed, remove crankcase oil-relief valve

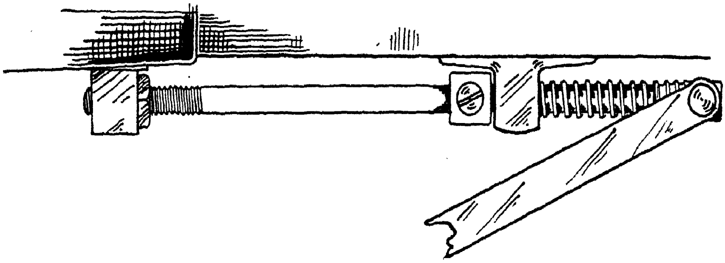


Fig. 2.—ADJUSTMENT FOR PEDAL TRAVEL

(situated at front end of left-hand (passenger) side of engine), thoroughly clean out, and if ball is ridged or pitted renew.

CLUTCH

The Borg & Beck clutch calls for no adjustment, nor is such provided. Clutch troubles are infrequent, and are usually confined to slip. A slipping clutch can be traced to one of two faults :

(1) Incorrect adjustment of the pedal.

(2) Grease or oil on driven-plate facings.

Trouble as in (1) can be due to the absence of free movement in the pedal, causing a slight pressure on the thrust release-lever plate. Adjust position of stop where indicated in diagram to allow $\frac{1}{16}$-in. play in pedal.

If clutch slip is the result of (2), there is no alternative but to remove the unit and dismantle the clutch as described previously. While swilling off all traces of oil or grease may improve matters, the only satisfactory cure is to have the driven-plate assembly refaced.

In the event of trouble being experienced with the clutch not freeing, it is probably due to an excessive amount of travel in the pedal. Adjust as indicated in Fig. 2.

GEARBOX

No adjustments are required. If for any reason the cover is removed it is advisable to slide it backwards before lifting, otherwise there is a possibility of the gear selector springs being dropped in. On refitting the gearbox to the chassis after removal see that holding-down bolts drop nicely into place. Should at any time it be found necessary to " spring " the box to allow bolts to enter holes in chassis cross-member it would indicate misalignment that may have resulted from collision, which may not have been discovered during process of repairs. Mounting bolts should be tightened fully.

THE DAIMLER 15 ENGINE

F

Model	*Bore*		*Stroke*	*Cubic Capacity*
1933 and 1934	63·5 mm.	×	95 mm.	1805 cc.
1935 and 1936	63·5 mm.	×	105 mm.	2003 cc.
1937 and 1938	66 mm.	×	105·4 mm.	2166 cc.

Refinements and improvements have appeared from time to time, and where they have affected the repairs instructions special mention will be made.

The engine has push-rod-operated overhead valves of conventional

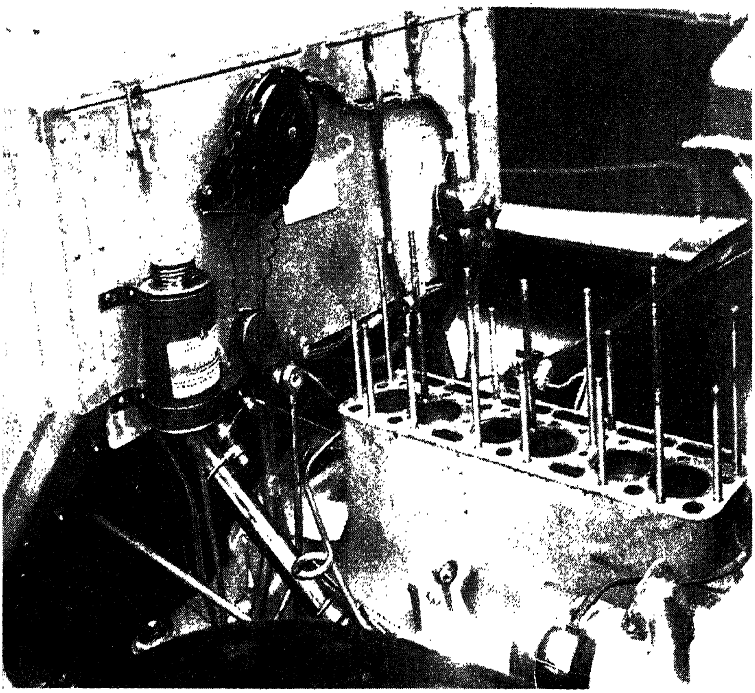


Fig. 1.—DAIMLER 15 H.P. WITH CYLINDER HEAD REMOVED FOR DECARBONISING

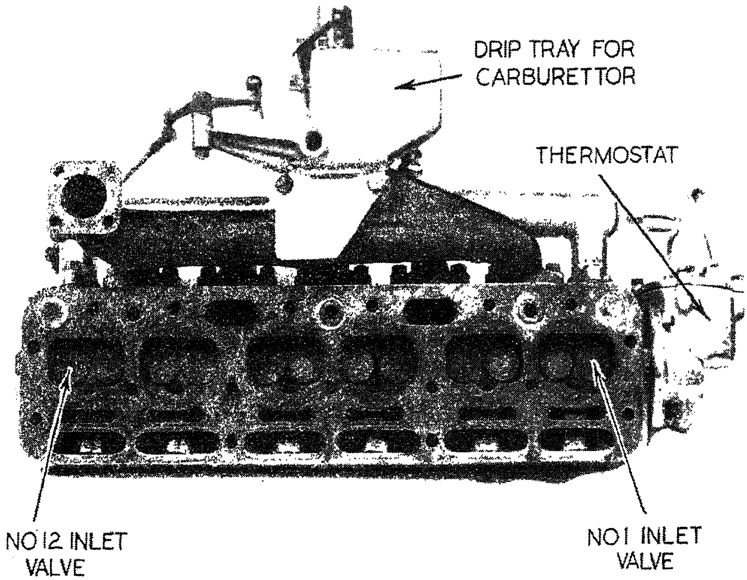


Fig. 2.—INVERTED VIEW OF CYLINDER HEAD (1935 MODEL)

design. The crankshaft is supported on four main bearings of ample dimensions, and a vibration damper is fitted to the front end of the crankshaft to eliminate any " whip " when the engine is accelerated suddenly.

Lubrication

Lubrication is full pressure from the main oil pump. Oil is fed direct to the main and big-end bearings and to the rocker gear under pressure. The gear-type oil pump is driven vertically from a single skew-gear on the camshaft. The camshaft, which is supported by five bearings, runs in an oil bath throughout its length.

Figs. 1 and 2 show the offside and nearside views of a 1935 engine. In order to drain the water from the radiator and water jackets, a tap is provided on the bottom water pipe leading from the water pump to the radiator.

Cooling is by a water pump driven from the dynamo through a special type of coupling. A self-sealing graphite gland is fitted in the pump, and requires little or no attention.

Dismantling for Decarbonising

Decarbonising follows the usual orthodox manner associated with an overhead-valve engine with detachable head. The rocker gear must first

be removed, and it is advisable to unscrew the nuts steadily a few turns each one at a time, as some of the springs will be under compression. Remove the rocker gear complete and note carefully the positions of rockers, distance-pieces, etc., as this will greatly assist when reassembling. Remove push-rods and mark them, so that each one is returned to the same position. This will greatly assist in setting the tappets later. Undo cylinder-head nuts, etc., and remove head complete with manifold as shown in Fig. 2.

When removing valves do not forget to remove the small circlips which are attached to the ends of the valve stems. These are fitted to prevent the valve falling in should a valve spring need replacing without removing cylinder head.

The exhaust and induction manifolds should be removed and the ports thoroughly scraped of all carbon.

It is advisable to drain the sump when decarbonising and refill with fresh oil. The tappet cover should be removed and the tappet chest thoroughly washed out. It will be found advantageous to leave the tappet cover off until fitting push-rods, as some difficulty may be experienced in registering the rods in the tappets. When refilling sump, prime the by-pass pipe and fill oil-filter body (if detachable-type body is fitted), to obviate any chance of an air lock in the system.

When refitting cylinder head examine gasket ; if there is any doubt as to its condition, it is always advisable to fit a new one. This applies to all joints. The gasket should be fitted with a good-quality jointing

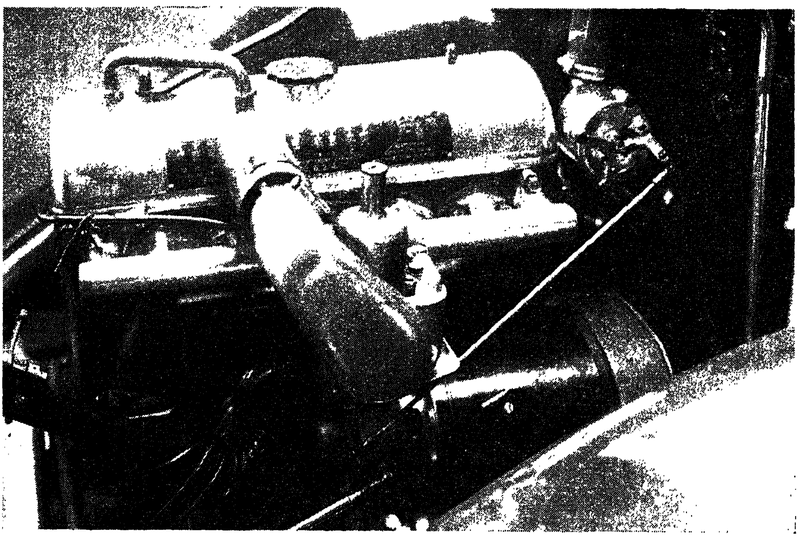


Fig. 3.—SHOWING TAPPET CLEARANCE PLATE ON VALVE COVER

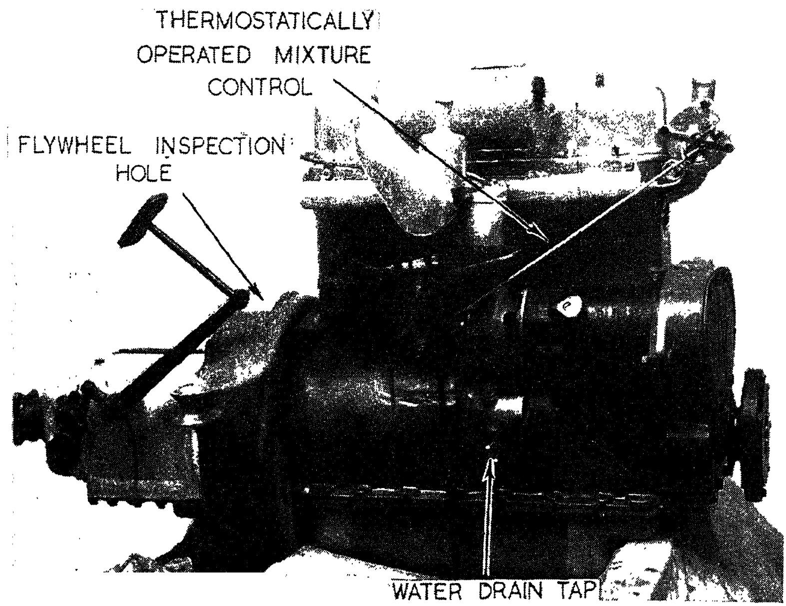


Fig. 4.—OFFSIDE VIEW OF ENGINE

compound, and the nuts screwed down evenly, starting in the centre of the head and working towards the ends.

Tappet Clearances

To avoid the risk of valve burning and frequent decarbonising, and also to obtain the maximum efficiency from the engine, it is essential to pay particular attention to the tappet clearances. The individual best tappet clearances are marked (in thousands of an inch) on a plate attached to the engine cover, and the necessary feelers should be kept in the tool kit. The engine should be at normal running temperature when the tappets are set, and after decarbonising they should be checked after 200 miles, when the cylinder-head nuts, etc., are finally tightened down.

With the type of camshaft fitted to the Daimler 15 engine, it is very important to see that the valve is in the fully closed position when clearance is checked. It is necessary, therefore, to check and adjust (if necessary) in the following manner: Turn the engine until No. 12 valve (i.e. the inlet valve of No. 6 cylinder) is fully open. This is the position to check and adjust No. 1 valve (inlet valve of No. 1 cylinder). Repeat by turning engine until No. 11 valve (i.e. exhaust valve of No. 6 cylinder) is fully open, and proceed to check and adjust No. 2 valve, and so on until all valves have received attention.

Connecting-rod Removal

The method of removing connecting rods varies according to year of manufacture. On the 1933 and 1934 models it is possible to remove the piston from the base, but it greatly facilitates assembly if the cylinder head is removed and piston withdrawn through the bore. The 1933 model has aluminium pads fitted to the gudgeon pins, and it is only necessary to remove big-end bearing cap, push the rod up the bore until the gudgeon pin is showing, knock out gudgeon pin, and remove piston from the top and rod from the base.

On the later models the gudgeon pin is held by a fixing bolt and locking plate, and a special spanner is necessary to undo the fixing bolt. This spanner is a box spanner about 14 in. long, and can be obtained from the Daimler Co. at a small cost. The engine should be turned until the rod to be removed is at the bottom of its stroke. The locking plate can then be bent back and a box spanner fitted on the fixing bolt. When assembling, a little difficulty may be experienced in aligning the groove in the gudgeon pin to insert the fixing bolt. It is advisable to have a thin, tapered bar, which can be inserted in the fixing-bolt hole and worked about until the pin is in the correct position to take the bolt.

Bearings

Replacement connecting rods are supplied by the Daimler Co. ready to fit and do not require any scraping. Main bearings have to be bored in

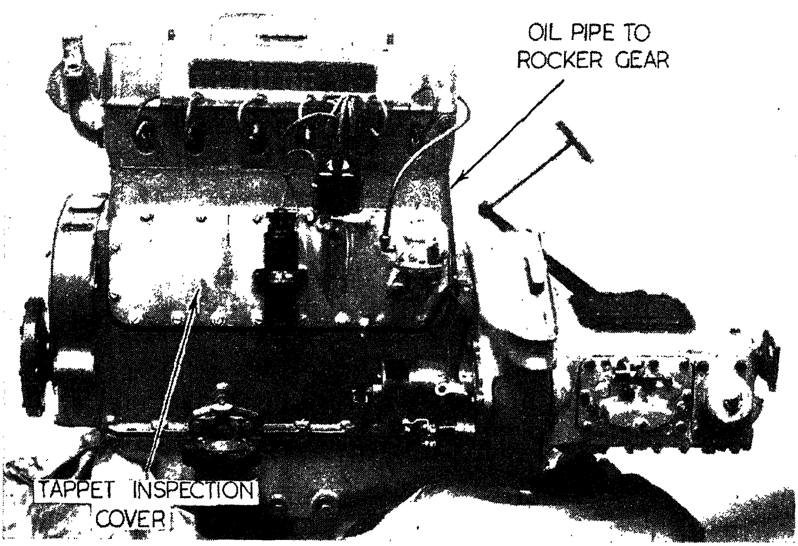


Fig. 5.—NEARSIDE VIEW OF 15 ENGINE

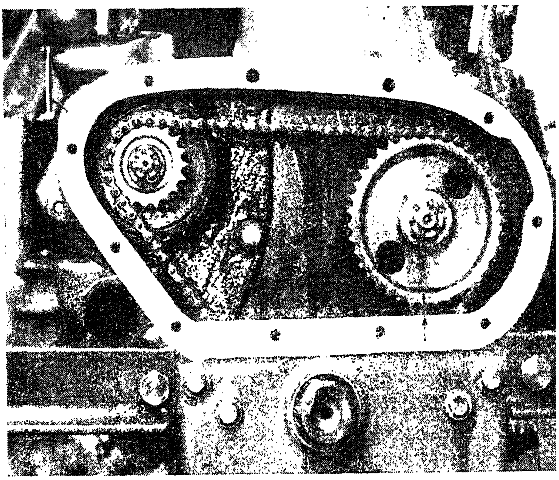


Fig. 6.—VALVE TIMING MARKS

line, and it is recommended, therefore, to return the engine to the makers for these to be fitted.

Fitting New Piston Rings

When piston rings are fitted after reboring cylinders, or for any other reason, they should be gapped so that the clearance between the butt faces when fitted in the cylinder bore lies between ·006 in. and ·010 in. The side clearance of the rings should lie between ·015 in. and ·0025 in., i.e. a ·002 in. feeler should be a tight fit in the piston-ring groove when the piston ring is fitted. In order to obtain a good fit between the piston and cylinder bore, the pistons are graded, and the grade letter, which is stamped on the crown of the piston, should be noted when ordering spares.

Pistons are graded in the following manner :

	Piston	*Cylinder Bore*
Grade J	2·4971–2·4974 in.	2·4994–2·4997 in
Grade K	2·4974–2·4977 in.	2·4997–2·5000 in
Grade L	2·4977–2·4980 in.	2·5000–2·5003 in
Grade M	2·4980–2·4983 in.	2·5003–2·5006 in
Grade N	2·4983–2·4986 in.	2·5006–2·5009 in
Grade O	2·4986–2·4989 in.	2·5009–2·5012 in

These figures are for the 1934–5 and 1936 models, but clearances are applicable to all Daimler pistons.

Valve Timing

Valve timing varies slightly on the various models, and below is given a table of the timings for the various list numbers. The engine list number is to be found on a brass plate on the nearside of the engine on the timing case.

Engine List No.	Exhaust Valve		Inlet Valve		Theoretical Tappet Clearance
	Opens	Closes	Opens	Closes	
22325 25160, 25488	60° B.B.D.C.	8° A.T.D.C.	16° A.T.D.C.	36° A.B.D.C.	·0547 in.
22402, 22700 22917	45° B.B.D.C.	5° A.T.D.C.	T.D.C.	50° A.B.D.C.	·0547 in.
25471, 26100 26495	45° B.B.D.C.	5° A.T.D.C.	T.D.C.	50° A.B.D.C.	·0605 in.

To check and reset valve timing, marks are provided on the camshaft-chain wheel and chain case (*see* Fig. 6). In order to remove cover plate from timing case and remove timing chain, it is necessary first to remove the radiator. This job should require attention only when the engine is completely dismantled, as it is only on very rare occasions, when the timing chain is badly stretched through wear, that the timing is liable to slip.

Wear on the timing chain can be taken up by slackening the three nuts securing dynamo to timing case, and rotating dynamo bodily in an anti-clockwise direction (looking from the rear) until it reaches the limit of its travel. Hold dynamo firmly in that position and tighten up the nuts.

Ignition Timing

To reset ignition timing, turn engine by hand until No. 1 piston is at the top of its compression stroke (No. 12 valve just opening and No. 11 just closing). Set No. 1 piston exactly at top dead centre. Remove cover on front of nearside engine-bearer aim (1933 and 1934 models only), and set mark on flywheel to coincide with mark on bearer. On later models set mark to coincide with setscrew on the top of the flywheel housing.

Set ignition control (when fitted) at fully retarded position, remove distributor top and undo pinch-bolt. Turn the rotor gently as far clockwise as it will go, and, holding it in this position rotate distributor body until contact points are just breaking on No. 1 sparking-plug lead.

Automatic Thermostat-mixture Control

It is possible that leakage may occur at the gland ring on the thermostat, thus preventing the proper functioning of the mixture control to the carburettor, which will cause difficult starting.

It is then necessary to fit a new gland washer, the instructions being as follows :

Remove the thermostat from the water-circulation pipe, and unscrew the top aluminium die-casting from the thermostat (if the casing of the

thermostat is held in one hand, the aluminium die-casting can be easily unscrewed). Then remove lever and withdraw central spindle. Remove the damaged gland washer. The new rolling gland washer should be placed on the thread at the end of the spindle, and then pushed in to the gland recess in the aluminium die-casting, so that the gland rolls on to the spindle.

Next replace lever and work backwards and forwards a number of times (about fifty) so that the gland washer centralises in the recess in the aluminium die-casting. This operation is very important, as it prevents the gland washer from "jamming" at the top or bottom of the gland.

The die-casting should then be screwed on to the thermostat, making sure that the vacuum washer is in between the thermostat and the die-casting.

It is essential that the rolling-ring spindle should be central in the gland nut; if not, a leakage will occur.

It is merely necessary to hold the cup casing and slightly rotate the die-casting. This will centralise the spindle.

THE REPAIR OF A.E.C. OIL-ENGINES

THE high-speed Diesel oil or compression-ignition engine operates upon a different cycle from that of the petrol engine, for it does not draw a mixture of fuel and air into the working cylinders, nor does it require an electric spark to ignite the fuel and air. It may, therefore, be of advantage to readers who are not familiar with the Diesel engine to describe briefly the principle of operation of a four-cycle oil-engine, before we deal with the repair of A.E.C. engines of this type.

How the Diesel Engine Works

The four-cycle oil-engine cylinder has the same types of inlet and exhaust valves as the petrol engine. These valves are operated from the camshaft, which runs at one-half the crankshaft speed. It has a different shape of combustion chamber and employs a fuel-spraying device, but has no sparking plugs. In regard to the pistons, connecting-rods, crankshaft, water-cooling, lubrication, etc., the oil-engine is practically identical with the petrol engine in its arrangements. In order to explain the working of the oil-engine we shall take as one of the simplest examples for this purpose the direct-injection type illustrated diagrammatically in Fig. 1. (The principle is the same as in the A.E.C. oil-engine, with the exception of the combustion head, which has an auxiliary combustion chamber as described later.) The four diagrams A, B, C, and D refer to the induction, compression, combustion and expansion, and exhaust strokes, respectively.

Induction Stroke

In diagram *A*, Fig. 1, the piston is shown descending on its suction stroke, the inlet valve being open and pure air drawn in. The valve is operated by a half-speed cam just as in the case of the petrol engine. The exhaust valve remains closed during this stroke.

Compression Stroke

In *B*, Fig. 1, the piston is just commencing to ascend on its compression stroke, both the inlet and exhaust valve remaining closed. A much higher compression, viz. from 450 to 600 lb. per square inch is employed than in the petrol engine (80 to 130 lb. per square inch). The compressed air becomes heated by this high compression, its temperature rising from 370° to 450° C. by the end of the stroke.

Just before the piston reaches the latter position the fuel-injection

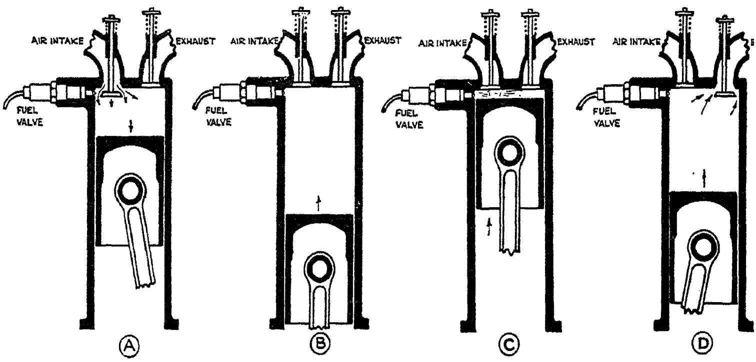


Fig. 1.—PRINCIPLE OF FOUR-CYCLE DIESEL ENGINE

The four diagrams show the induction, compression, combustion and expansion, and exhaust strokes.

nozzle is arranged to open, so as to admit a fine spray of fuel. The latter spreads across the specially shaped combustion chamber formed by the hemispherical piston head and the flat top of the cylinder. The injected fuel is thus intimately mixed with the air particles.

Combustion and Expansion Stroke

Diagram *C* shows the piston just near the end of its compression stroke, with the injected fuel spray burning with the compressed air. The self-ignition temperature of Diesel oil is about 300° C. to 350° C., whilst the temperature of the compressed air is usually from 370° to 450° C. In consequence the oil at once burns as it is sprayed into the cylinder head.

The combustion of the fuel in this manner continues during the whole period of fuel injection, viz. from 10° to 20° of crank-angle, the pressure rising to some extent, namely, from the compression-pressure value to about 700 to 900 lb. per square inch, in automobile-type Diesel engines. The temperature of the gases, forming the products of combustion, rises considerably, so that the next down stroke of the piston (Diagram C) is a power stroke due to the expansion effect of these hot gases.

Exhaust Stroke

Just before the piston reaches the bottom of its expansion stroke—usually about 30° to 40° of crank-angle before bottom dead centre—the exhaust valve commences to open, thus allowing the burnt products of combustion to escape into the exhaust pipe and silencer. On the succeeding up-stroke (Diagram D) the piston sweeps out the burnt products through the exhaust valve, the air-inlet valve remaining closed. The exhaust valve closes when the piston reaches the top of its stroke.

The cycle of operations is thus complete and the piston is again in the position for another similar cycle to commence.

How the Power Output is Regulated

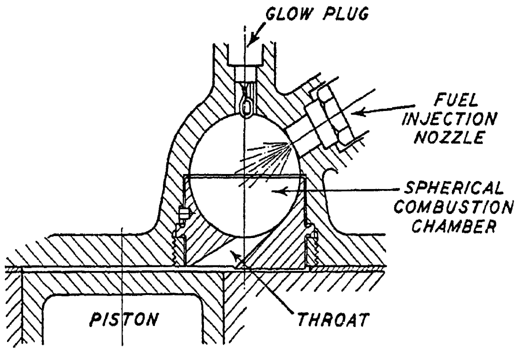


Fig. 2.—THE TURBULENT AUXILIARY CHAMBER COMBUSTION HEAD

Under full-load conditions, the combustion of the fuel injected into the cylinder head continues during the whole period of the injection, i.e. until nearly all of the oxygen of the compressed-air charge has been used up. When it is desired to run the engine under " idling " or part-load conditions, the period of fuel injection is reduced, so that a smaller quantity of fuel is injected.

It will thus be seen that the speed or power output of the Diesel engine is regulated in a totally different manner from the petrol type. The Diesel engine always takes in a full charge of air, whether it is idling or working at full load, but the quantity of fuel is progressively increased, from idling to full-load conditions, by increasing the time or period of injection. The usual period as referred to the angle turned by the crankshaft for full-load injection is from 25° to 35° ; for idling it will be only a few degrees.

The moment at which injection commences is generally from about 10° to 20° before the piston reaches its top centre on the compression stroke. This timing of the injection, or injection advance, is very important. The actual timing adopted depends in each case upon the design and speed of the engine.

The Combustion Chamber on A.E.C. Engines

The combustion system on A.E.C. engines is based upon the use of a small auxiliary chamber communicating with the cylinder head by a small passage placed tangentially (*see* Fig. 2). When the piston ascends on its compression stroke it forces the air at great velocity through this passage and into the auxiliary chamber. Since the piston practically reaches the top of the cylinder, all of the air charge is thus forced into the auxiliary chamber in a state of great turbulence. The injection nozzle is of the single-orifice type and is arranged to inject the fuel across the direction of the turbulent air charge, so that the latter swirls past the orifice, picking up the fuel particles and intimately mixing with them during combustion.

Glow Plugs

For starting oil-engines from cold, on the A.E.C. engine are special plugs, known as glow or heater plugs, having an exposed resistance coil within the combustion chamber. This coil is heated to redness for about half a minute before the engine is cranked over, so as to warm the combustion chamber sufficiently for starting-purposes.

Types of A.E.C. Oil-engines

The present range of A.E.C. oil-engines includes two four-cylinder ones, of 75 and 85 h.p., and two six-cylinder models, of 100 and 115 h.p. The respective dimensions of these engines are 108 mm. bore × 146 mm. stroke, 120 mm. bore × 146 mm. stroke, 105 mm. bore × 130 mm. stroke, and 105 mm. bore × 146 mm. stroke.

An important feature of all A.E.C. oil-engines is that the offsides are kept clear of all accessories, the latter being arranged on the nearside, where they are readily accessible from the pavement.

THE SIX-CYLINDER OIL-ENGINE

The engine is fitted with overhead valves which are operated by means of push-rods and rockers from a camshaft carried in the cylinder block.

The camshaft is driven from the crankshaft by a chain which also forms the drive to the fan, the water pump, the dynamo, the vacuum exhauster, and the fuel pump. The latter two are mounted in tandem on the nearside of the engine, whilst the water pump, which is mounted on the forward end of the crankcase, is driven by an extension of the dynamo-drive shaft. The water pump is fitted with a special graphite packing which requires no attention, and this eliminates the constant nuisance of repacking the spindle.

Full-pressure lubrication is fitted for the main and big-end bearings, and a patented metering device feeds a small quantity of oil from the main pump to the overhead-valve gear.

Three-point suspension is provided for the engine unit, the front of the engine being carried by a removable cross-member bolted to the dumb-irons and fixing to a bracket on the front of the crankcase which carries the starting-handle.

The Cylinder Heads

The cylinder heads are formed in two units, each covering three cylinders, and they are, as regards their essential details, interchangeable. The valve-gear mechanism is carried in the head and is totally enclosed by a cover which also forms the air-intake pipe.

Removal of Valve Springs

Valve springs can be easily replaced without removing the valves. Remove rocker shaft complete with brackets and rockers, after first disconnecting the oil pipes feeding the rocker bearings.

Bring the piston under the valve, the spring of which is to be removed, on to its top dead centre, depress valve spring with a suitable valve lifter, and remove split collar from valve stem.

Removal of Cylinder Heads

The cylinder heads are removed separately, and the process is practically identical for both the front and the back.

Remove the cylinder-head cover. Disconnect the top water pipe; it is generally easier to break the flanged joint on the cylinder head than to disturb the rubber connection. Remove buss bar from heater plugs, disconnect injector pipes.

Disconnect the exhaust-pipe flange and uncouple the two halves of the exhaust manifold where it is joined in the centre. Remove the water pipe coupling the two heads together at the nearside of the engine, and disconnect the water-feed pipe from the back head. Remove the rockers and brackets, and, for convenience, lift out the push-rods operating the valves.

Two special jacknuts are fitted to each head to facilitate removal, and are so arranged that as they are unscrewed they will lift the head clear of the cylinder. *These two nuts must, therefore, not be unscrewed until all the other nuts have been removed.* When this has been done, unscrew the two jacknuts evenly until the nuts are disengaged from their studs.

Regrinding Valves

The seating angle for the valves is 30°, and thus differs from the usual A.E.C. petrol-engine practice.

It should never be necessary to remove the venturi from the cylinder head, and in the few cases where this is found necessary from one cause or another, the complete head should be returned to the factory for inspection and replacement.

Replacing Cylinder Head

Lower the head carefully over the studs until it comes to rest on the jacknuts. These hold it about $\frac{1}{2}$ in. above the cylinder. Keeping the head parallel with the cylinder, bring the two together by giving each jacknut alternately a few turns with the spanner. Tighten the head down carefully, so as to avoid distortion, giving each nut a few turns at a time until all are uniformly tight. Always tighten up again after the engine has been run and whilst still hot.

The push-rods should now be replaced, making sure that the lower ends are engaging properly with the tappets. Replace the rocker assembly, connect up water and exhaust pipes, cylinder-head cover, and injector pipes.

Note.—The cylinder-head cover also forms the air-intake pipe, and particular care should be taken when running the engine without the

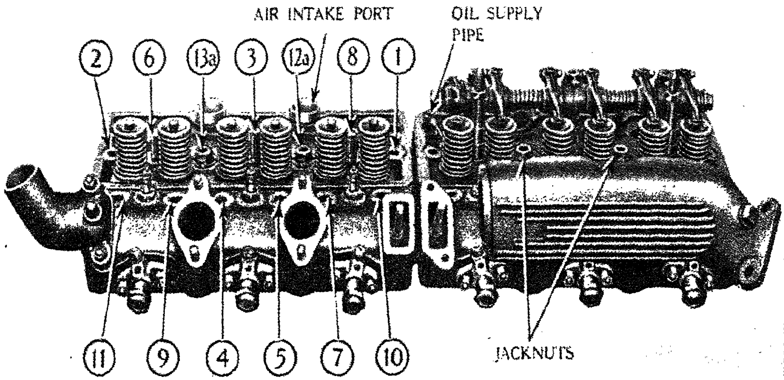


Fig. 3.—CYLINDER HEAD AND VALVE GEAR SHOWING ORDER OF TIGHTENING HEAD NUTS (115-H.P. ENGINE)

Nuts marked " a " are jack nuts and should be *lightly* tightened down before any of the other nuts. They should be the last to be finally tightened. The cylinder head should be kept tightened down and it is a good plan to do this periodically every week. It has been found that a very large proportion of cracked cylinder heads are the result of this omission.

cover to see that nothing is dropped into the vertical air-intake ports in the cylinder heads.

Valve Adjustment

The valve should be adjusted when the engine is hot, and a clearance of from ·008 in. to ·010 in. given between each valve and rocker.

Valve Timing

The valve timing is given below in crankshaft degrees, and for convenience of measuring, the approximate measurements along the outside diameter of the flywheel are given in brackets :

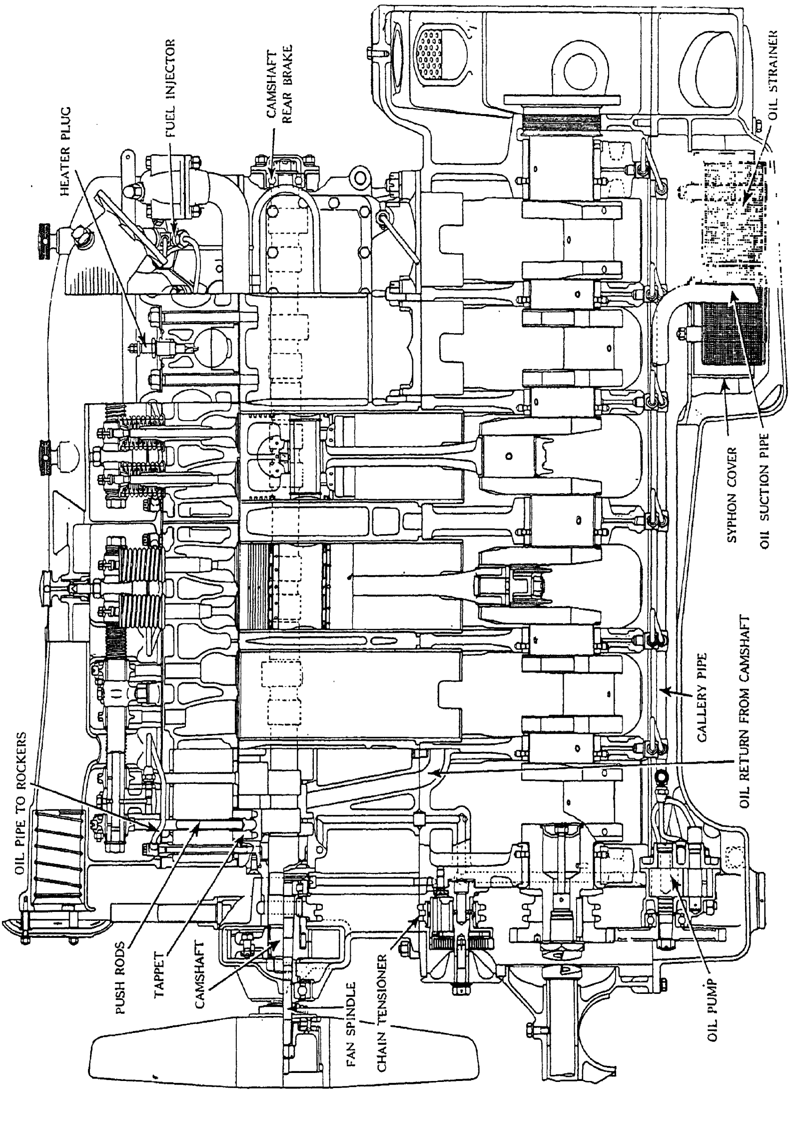
Exhaust closes	8° ($1\frac{1}{4}$ in.)	after T.D.C.
Inlet opens	10° ($1\frac{1}{2}$ in.)	before T.D.C.
Inlet closes	38° ($5\frac{11}{16}$ in.)	after B.D.C.
Exhaust opens	40° (6 in.)	before B.D.C.

The Connecting Rods and Bearings

The big-end bearings are carried in a steel shell, and are made in a special lead-bronze alloy. Except for a short " mud groove " at the joint between the rod and the cap, the bearing has a plain surface free from any grooving. Special attention should be given to the fit of these bearings, and they should on *no account whatever be fitted with a smaller clearance than from* ·004 in. to ·005 in.

The surface of the rod and cap must on no account be filed. End play between the rod and crank should be from ·006 in. to ·008 in. when new.

Fig. 4.—LONGITUDINAL CROSS SECTION OF 115-H.P. OIL ENGINE



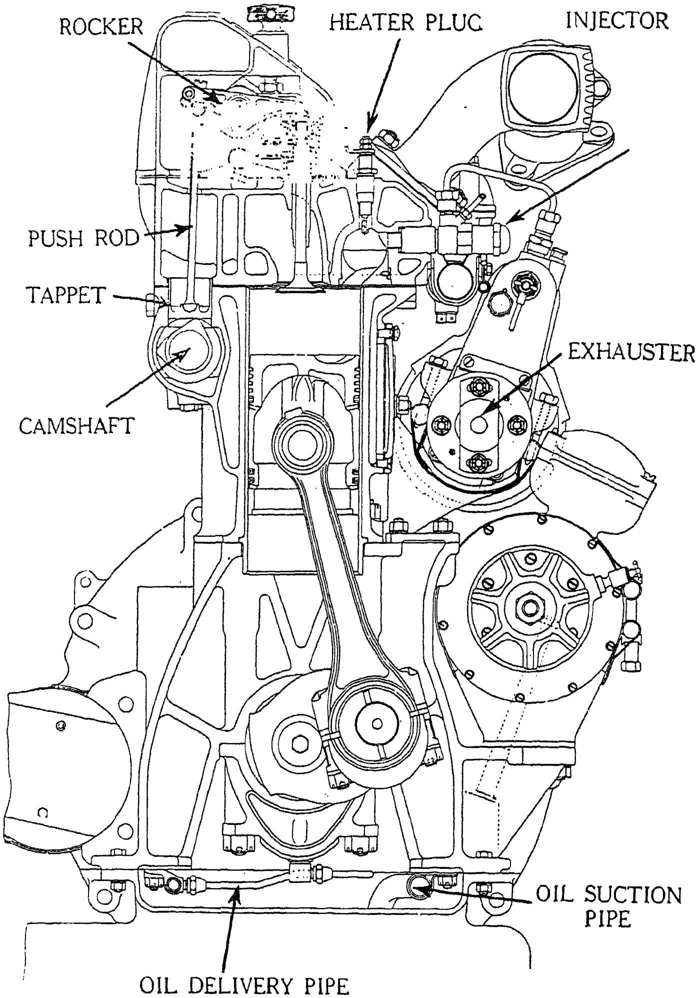


Fig. 5.—Cross-section of 115-h.p. six-cylinder engine

To Remove the Pistons and Connecting Rod

The pistons must be removed by passing the connecting rod up through the cylinders. They cannot be removed through the crankcase.

Remove the cylinder head as already described, and the sump. Remove the connecting-rod caps. Push the piston up the cylinder until it can be grasped from above and the piston and rod lifted clear of the cylinders. Take care that the rod does not score the cylinder bore when passing through it.

The gudgeon pin floats in both the piston and the connecting rod, and is secured endwise by a "Seegar" ring sprung into grooves in the piston. To remove these spring rings, a special pair of pliers is provided, having small circular jaws. The fit of the gudgeon pin in the piston should be such that when the piston is at ordinary room temperature the pin can be forced in by the pressure of the two thumbs. On no account should the piston be reamed out. When fitting new pins, the pins must be selected to give the correct fit.

The pistons and rods are numbered in sequence, counting from the forward end, and must be refitted to the cylinders from which they are removed.

It is very important that the pistons are assembled so that the depressions are on the same side of the engine as the venturis, i.e. the near-side.

In order that the rings can be entered into the bore without difficulty, a guide is supplied with the tool kit. This guide should be well covered with engine oil and passed over the piston before the rod is dropped down the cylinder.

Piston Ring Fits

When new, the clearance of the top rings in their grooves is from ·0035 in. to ·0045 in.; all the other rings have from ·0015 in. to ·0025 in. side clearance. Rings which show blackened or discoloured patches, either on the working surfaces or the sides, should at once be replaced by new ones. When fitting new rings, a gap clearance of ·012 in. should be allowed when the ring is square in the cylinder.

Piston Clearance

The clearance at the skirt of the piston, when new, is from ·006 to ·008 in.

To Remove the Cylinder Block

After removing the cylinder head and push-rods, remove the fuel pump and the exhauster. There are packing shims under the exhauster which should be replaced when reassembling. Remove the cover over the top of the timing case so that when the block is lifted the camshaft gear and the front camshaft bearing will be removed complete on the

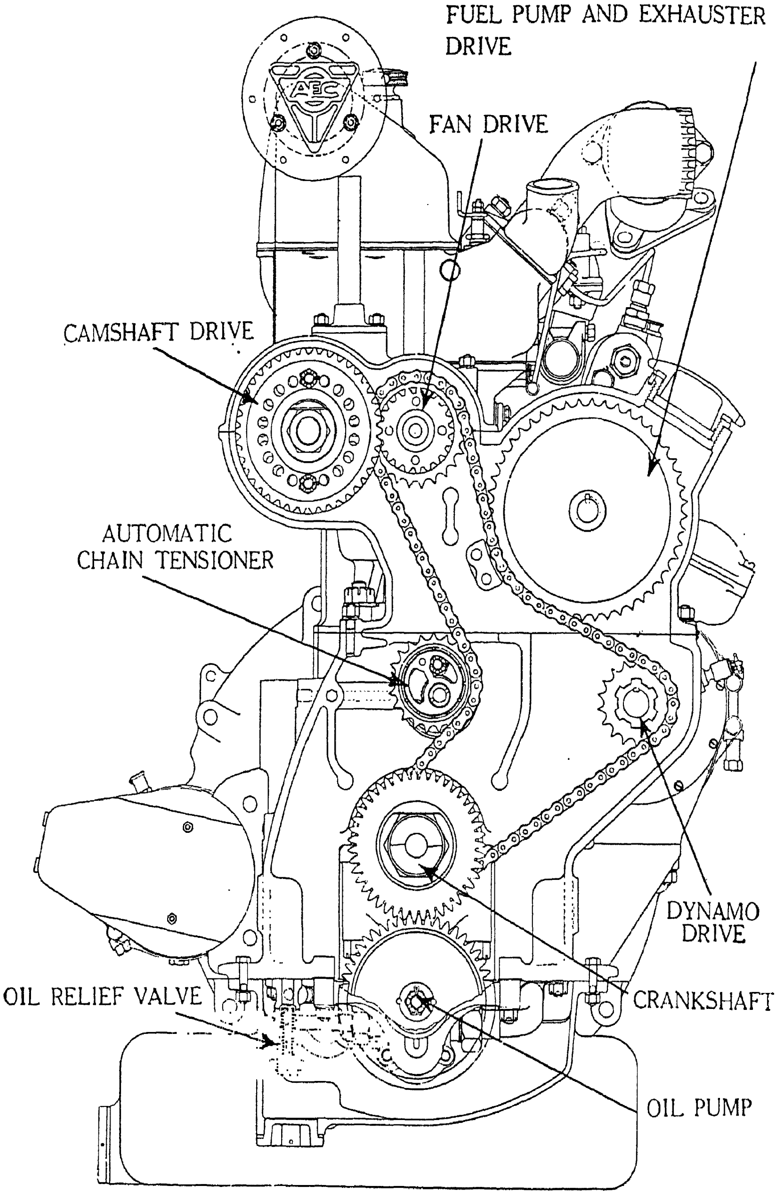


Fig. 6.—ARRANGEMENT OF CHAIN DRIVE, 115-H.P. SIX-CYLINDER ENGINE

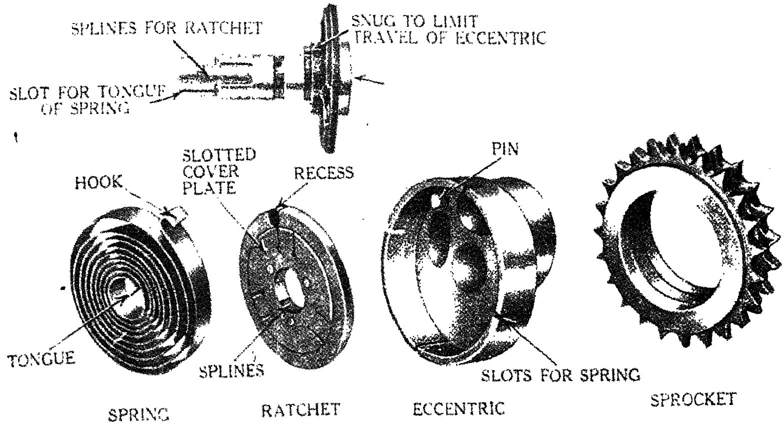


Fig. 7.—DETAILS OF CHAIN TENSIONER

block. On removing the nuts which hold the block to the crankcase, the block can be lifted off. It is highly desirable that the pistons be drawn before the block is lifted, as the replacement of the block over the six pistons is a rather difficult operation, particularly if working in the restricted space of the cab.

The Timing Case

To remove the timing case, the radiator and the cylinder block must first be removed as previously described. Then break the chain, remove the nuts securing the timing case to the engine, and lift up the timing case, allowing each end of the chain to unwrap. For breaking the chain, a rivet extractor is provided in the tool kit.

To Remove the Fan Spindle

Remove the fan, using the draw dog supplied in the tool kit, and remove the top cover from the timing case. This will expose the fan spindle, on which the chain sprocket and the camshaft-driving gear is mounted on a long taper. After breaking the chain the complete fan spindle can be lifted bodily out of the timing case.

To Remove Exhauster and Fuel Pump Drive Spindle

Remove the fuel pump and exhauster and also the exhauster driving coupling. Remove both the front and back covers, and unscrew the nut at the front securing the front ball race, and then knock the spindle through to the back, leaving the chain-wheel free in the timing case.

To Remove the Water Pump and Dynamo-drive Spindle

The water pump is secured to the front of the crankcase by two nuts, the removal of which allows the complete pump to be pulled forward off

its studs and also clear of the spigot extension of the dynamo-drive spindle. Remove the dynamo and the coupling flange on the end of the drive spindle, and drive out the spindle towards the front of the engine. The sprocket wheel, the ball bearing at the dynamo end, and the oil-thrower disc will be stripped off, while the bearing at the water-pump end, together with its thrower, will remain on the shaft.

Note.—It is quite unnecessary to remove either of the auxiliary shafts unless the sprockets or one of the ball bearings become worn and require renewal. Except in some such case as this, they should be left undisturbed.

To Remove the Chain Tensioner

The chain tensioner is situated in the crankcase.

Release the spring by freeing the outer end out from the slot in which it is located. The eccentric complete may then be pulled off. When removing the tensioner while the timing case and the chain are in position, the sprocket will be stripped off the eccentric as the latter is removed.

To Replace the Chain when Reassembling Timing Case on Engine

Remove the top cover from the timing case and leave the chain-tensioner sprocket hanging loosely on its spindle. Feed the chain into the timing case so that it wraps over the fan sprocket at the top and down on the underside of the exhauster and fuel-pump sprocket. Leave about an equal length of chain hanging down below the timing case on either side, and lower the timing case on to the crankcase so that the chain drops to the right of the tensioner sprocket on the offside, and over the dynamo sprocket on the nearside. Lower the timing case on to the crankcase and fix down with nuts. Then, from the underside of the engine, feed the offside end of the chain from the tensioner sprocket under the crankshaft sprocket, and join up to the other end with the slack end of the chain. Now fit the eccentric into the chain-tensioner sprocket and turn the eccentric in a clockwise direction as far as it will go, and replace the ratchet.

It is, of course, necessary to retime the engine when the chain has been removed, and this is dealt with in a later paragraph.

To Obtain the Correct Chain Tension

Turn the chain-tensioner eccentric as far as it will go in a clockwise direction, replace the ratchet with its slotted cover plate outwards, and engage the pin in the eccentric with the slot in the ratchet. Engage the tongue in the centre of the spring with the slot in the chain-tensioner spindle, and wind up three and a quarter turns in an anti-clockwise direction and lock the end into one of the four slots provided for it in the outer edge of the eccentric. A convenient tool for winding the spring can be made from a length of $\frac{1}{2}$-in. diameter round bar with a handle at one end; the other end is reduced to $\frac{3}{8}$-in. diameter for $\frac{1}{2}$ in., with a sawcut in the end to take the spring.

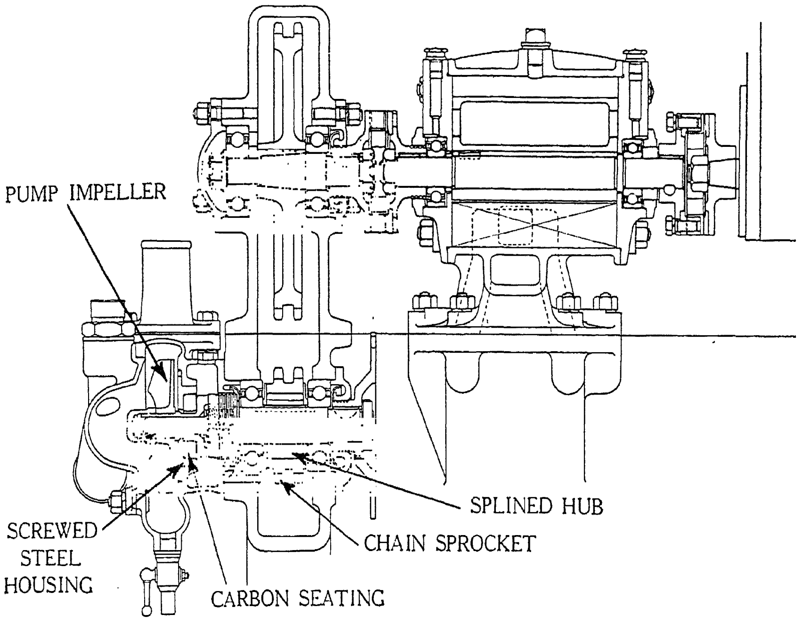


Fig. 8.—WATER PUMP AND DYNAMO DRIVE, 115-H.P. SIX-CYLINDER ENGINE

Replacing a Worn Chain

When it is merely necessary to replace a worn chain with a new part, it is not necessary to remove the timing case. The sump should be removed and the chain tensioner slacked back by releasing the spring. The chain should then be broken and the new chain attached to one end of it by means of a link. The engine should now be rotated so that the new chain is fed on the sprockets as the old one is removed. When completely fed on, the chain should be riveted up and the chain tensioner adjusted as previously described.

The Fan

The fan, being mounted on a positively-driven spindle forming a part of the timing-gear system, is driven through a small friction clutch so as to avoid undue stresses from sudden changes in engine speed.

The clutch consists of two plates, one of which forms the hub of the fan, and is keyed to the spindle, whilst the other, the pressure plate, is free on the spindle. Between the two plates is a third plate forming part of the fan itself, and which is faced on each side by a disc of friction material, the three plates being forced together by a spring which is placed around the spindle.

When in proper adjustment, the clutch should require a force of not

less than 15 lb. applied to the tip of one of the blades to cause it to slip. No actual adjustment of the clutch is provided, as the amount of slipping is so small as to cause a negligible amount of wear on the friction surfaces.

Insufficient driving force may, however, be occasioned by burrs raised on the friction material when handling, and removal of them will at once restore the necessary driving power. It is essential that the various surfaces should bed properly on each other.

If, in the course of time, the friction surfaces have worn sufficiently to reduce the driving power appreciably, they should either be renewed, or the spring force may be restored to its original value by the addition of washers placed between the spring and the sliding driving plate.

The Water Pump

The centrifugal water pump, which is mounted on the forward face of the crankcase, is driven by a dog from the dynamo-drive shaft. Packing of the usual kind is eliminated by the use of a special seating made of carbon against which runs a shoulder formed integral with the pump spindle. Positive contact between the two is assured by four coil springs placed between the end of the spindle and the dynamo-drive shaft.

The pump spindle is of stainless steel and is carried on an extension of the dynamo-drive shaft, with which it rotates, so that no lubrication of any kind is required for this spindle.

To Remove the Pump from Engine

Disconnect the bottom water connection from the radiator, the top water connection, and the two nuts securing the pump to the crankcase. The pump can now be removed by drawing it forward to clear the extension on the dynamo-drive shaft.

To Remove the Impeller

Remove the pump cover, unscrew the nut locking the impeller to the spindle, and screw off the impeller. The locknut and the impeller have left-hand threads.

Fitting Carbon Seating

Particular care is required in fitting the carbon seating, and when replacement becomes necessary, it is recommended that the pump should be returned to the factory for this purpose.

To replace the carbon seating, the following procedure must be adhered to if satisfactory results are to be obtained.

Unscrew the steel sleeve which carries the carbon seating and heat in oil until the old seating becomes easily removable. Do not attempt to chip out the old seating, as this will damage the recess, which is machined to within very accurate limits.

Carefully clean out the recess and heat sleeve over a gas-ring until it

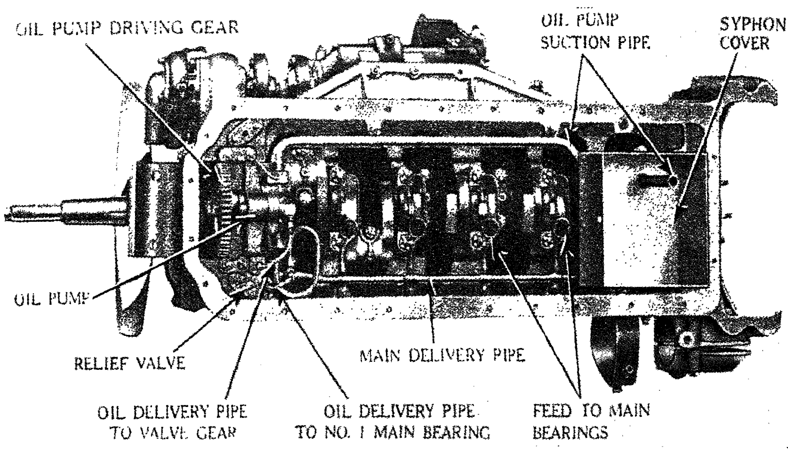


Fig. 9.—UNDERSIDE OF 115-H.P. SIX-CYLINDER ENGINE SHOWING OIL PIPES, ETC.

turns a pale straw colour, when the new seating should be dropped in and pushed up home against the back of the recess. Allow the sleeve to cool in air, and the seating will be tightly held in the recess. Screw the sleeve back into the pump body. The seating is made slightly convex so that an even marking all round will quickly be obtained. A good seating $\frac{1}{8}$ in. wide all round will make an efficient gland, and as wear takes place the width of the seating increases.

Care should be taken, when fitting in the spindle, that the inner edges of the carbon seating are not chipped; should chipping occur it will be necessary to renew the seating.

When replacing the water pump on the engine, make sure that the four springs are inserted between the spindle and the dynamo-drive shaft.

Oil Pump and Lubrication

Oil is fed to all main and crankpin bearings under pressure. The pistons and the gudgeon pins and camshaft bearings are supplied by splash.

To feed the valve gear, the spindle for the driven pump wheel is made hollow with a small hole, which faces towards the delivery side of the pump, drilled radially through to the inside. A second small hole is drilled between two of the teeth of the driven pump wheel. The two holes are arranged to coincide once per revolution and a small quantity of oil is thus forced into the interior of the spindle. By means of a copper pipe connected to the pump body the oil is led to a passage drilled in the crankcase and leading up through the cylinder block to the cylinder head, where it is distributed to the rocker shafts.

The oil-pump suction is taken from a strainer to prevent any foreign particles or large pieces of carbon from being fed into the pump.

Adjustment of Oil Pressure

On no account should the oil-pressure adjusting screw be interfered with, as this is set at the factory to give the optimum pressure in service.

During the annual overhaul, the hollow crankpins should be cleaned out, as, after a protracted period of operation, dirt from the oil will tend to collect inside.

The ends of the crankpins are closed by means of steel caps, which are held in place by a bolt running through the centre of the pin. These caps should be removed and the holes cleaned out.

When replacing the caps, see that the copper and asbestos washers which make the joint oil-tight have not been damaged or displaced. The bolt must be screwed up tight, copper washers being fitted under both the nut and the head of the bolt, and particular care must be taken to see that a good job is made, otherwise the failure of the connecting-rod bearing may result. It is essential, too, that before replacing the crank, the hollow crankpins are filled with oil with a syringe.

The instructions given above refer to the 115-h.p. six-cylinder engine. The 100-h.p. six-cylinder engine details, where they differ, are given below.

100-H.P. SIX-CYLINDER OIL-ENGINE

The crankcase and cylinder block are cast integral in cast iron, and wet liners are provided for the cylinder bores.

Overhead valves are fitted in two identical cylinder heads, which are, of course, detachable, and the valves are actuated by push-rods and rockers, from a gear-driven camshaft mounted in the crankcase. The fuel pump is also gear-driven and is accessibly mounted on the near side of the engine.

The fan and water-pump are built up on a common shaft and, with the dynamo, are driven by a twin belt from the front of the crankshaft. This drive is of the triangular type, with adjustment provided by means of the swinging dynamo saddle.

Full-pressure lubrication is provided as for the 115-h.p. engine.

Crankcase and Cylinder Block

This is a relatively simple casting, to which are fitted the seven main bearings and into which the wet cylinder liners are housed. The camshaft is also mounted in the crankcase, and runs direct in the cast-iron case without bushings.

Cylinder Sleeves

These are fitted into the cylinder block by pushing home by hand against a shoulder formed on the top of the sleeve. Water is prevented from entering the crankcase by two moulded rubber rings which are located in chamfered annular recesses in the crankcase.

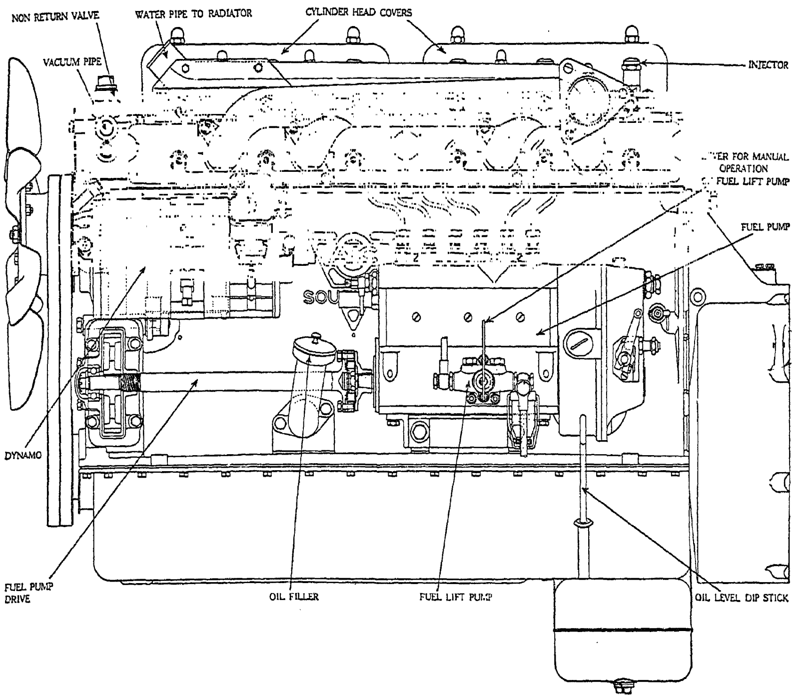


Fig. 10.—General arrangement of nearside of 100-h.p. six-cylinder oil-engine

Removing and replacing Sleeves

This operation can be done without removing the engine from the chassis, as no pressure is required. The cylinder head and pistons should of course be removed, and the old sleeve should then be tapped upwards from below.

The old rubbers should be removed, and it is important that the recess into which these fit should be thoroughly cleaned. Then put the new rubbers into these grooves and after first thoroughly smearing the outside diameter of the lower portion of the sleeve with soft soap, press the new sleeve down into place by hand pressure. The last half-inch or so, when the top diameter of the sleeve is engaging in the bore of the crankcase, will require to be lightly tapped down.

Never try to use old rubber rings when removing or replacing sleeves, and also be quite sure that the recesses are clean and that no foreign matter in the top diameter of the crankcase is preventing the sleeve from butting truly against its top shoulder.

To remove and replace the Cylinder Heads

Remove the cylinder head covers, the top water pipe, the exhaust manifold, and disconnect the fuel pipes and heater bar. Then remove

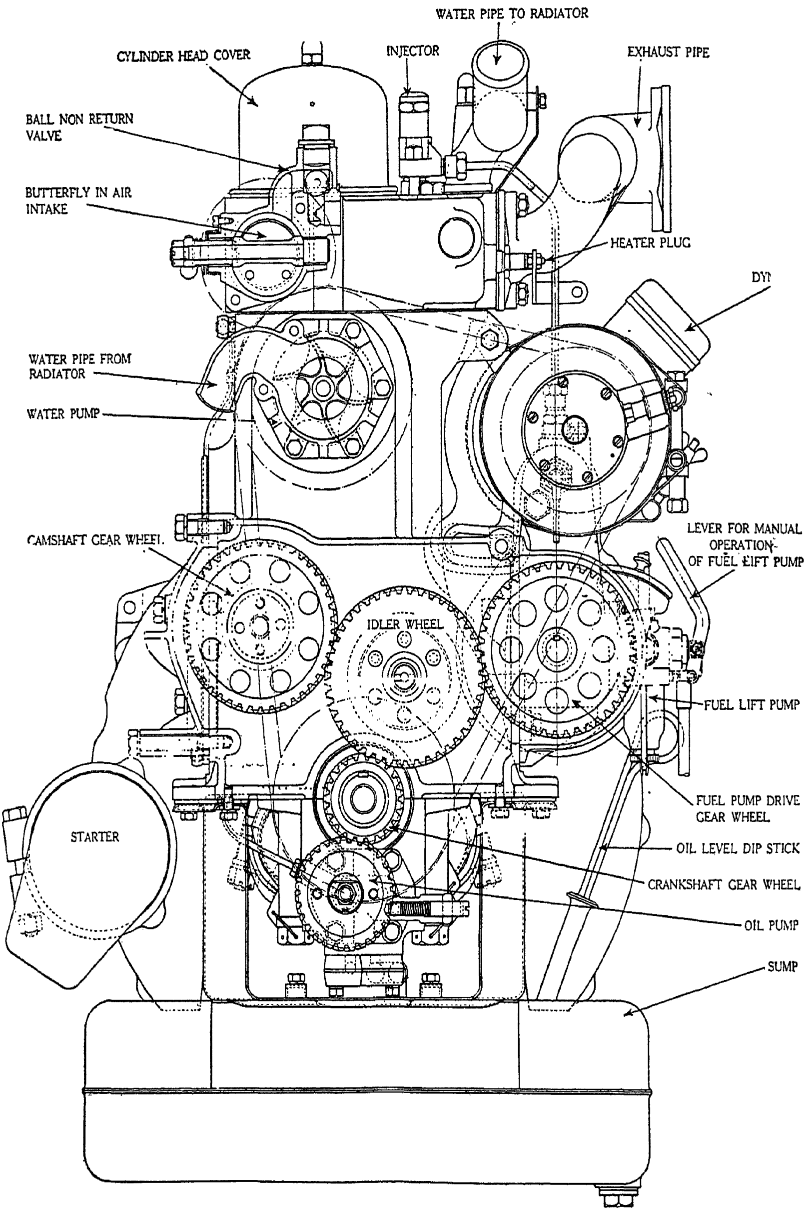


Fig. 11.—FRONT VIEW OF 100-H.P. ENGINE, SHOWING GEAR DRIVE TO AUXILIARIES

the rocker assemblies from each head and take out all the push-rods. Between the two heads, on the centre of the engine there is a joint on the air-intake port and this connection must be broken. It is formed, by a rubber ring over which is placed a "jubilee" hose clip. Unscrewing the clip will relieve the pressure of the ring against the face of the cylinder head and will permit—after the holding-down setscrews have been removed—of lifting each head in turn.

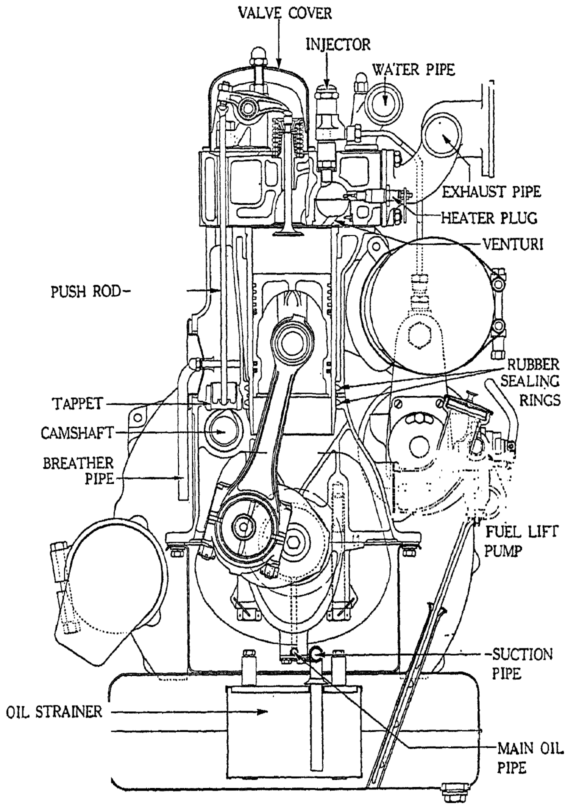


Fig. 12.—Cross-sectional arrangement of 100-h.p. engine

When replacing the heads first make quite sure that the gaskets are in good condition, and that the faces of the head and the block are quite clean.

Do not forget to tighten up the jubilee clip over the air joint between the two heads, as any leakage here will result in lack of vacuum when the brakes are applied.

Make quite sure, when the push-rods are inserted into the tappets, that they are in the spherical seat machined for them and not riding on the top of the central boss.

After the cylinder heads are replaced and the fuel pipes are again connected into the injectors, the air must be bled from the system, and this operation is described later on in the text.

The Camshaft, Tappets, and Camshaft Drive

Fig. 11 shows the front view of the gear drive to the camshaft and also to the fuel pump and oil-pressure pump. From this illustration it can be seen that an idler gear is interposed between the crankshaft, the

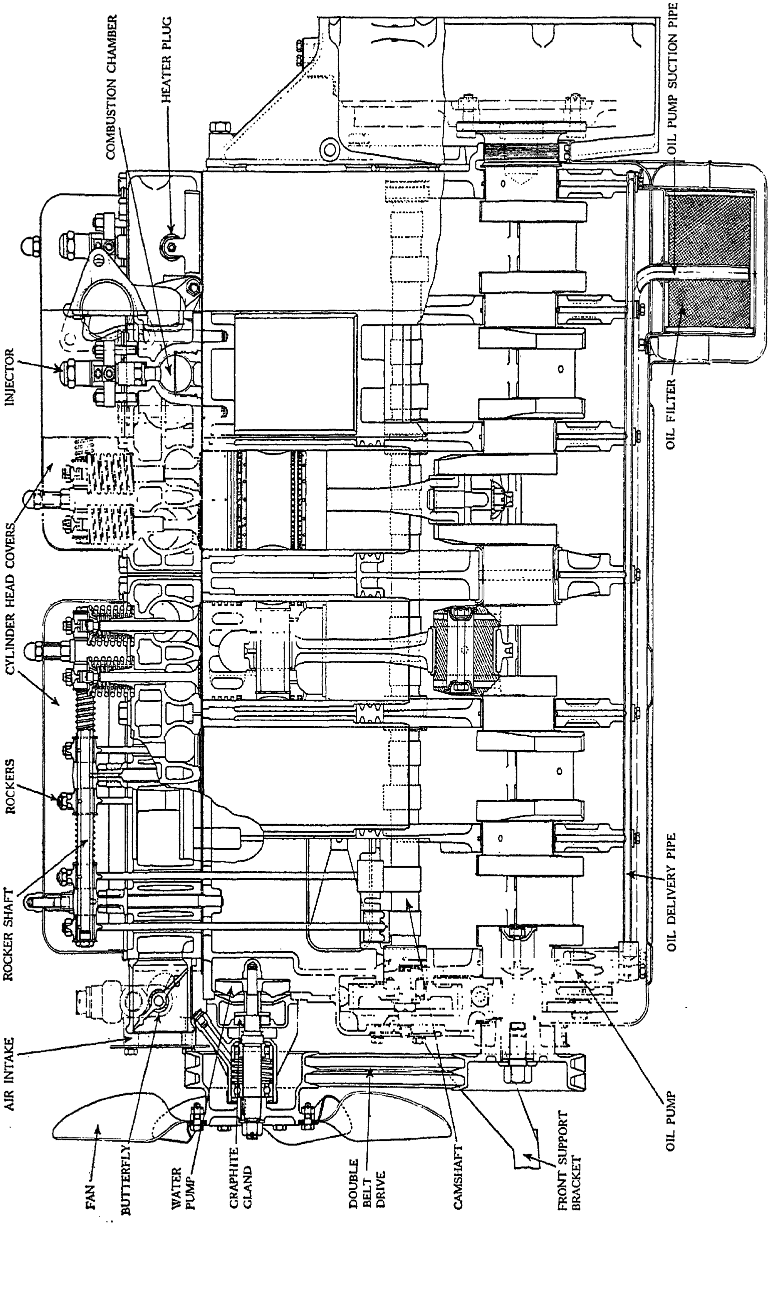


Fig. 13.—Arrangement of 100-H.P. Six-cylinder Engine

camshaft, and the fuel-pump gears, and this idler is mounted on a fixed spindle, which is fixed into the crankcase by means of two setscrews.

The camshaft gearwheel is affixed to the camshaft by a central, hexagon-headed setscrew, the end of which is extended to form the thrust-pad which locates the camshaft in an endwise direction. Incidentally, an end clearance of ·020 in. is allowed when assembling, and if a new camshaft is fitted, this point must be watched so that excessive float is not allowed on the one hand nor end seizure on the other.

This end float is adjusted by means of shims under the front end cover.

The drive from the gearwheel to the camshaft is taken on two dowels driven into the end of the camshaft and engaging two of four holes drilled in the camshaft gearwheel. These four holes are so spaced that, by engaging the second pair of holes, the valve timing is altered by half of one tooth.

Tappets

Access to the tappets is through the tappet covers provided on the offside of the crankcase. The tappets must be first removed before the camshaft is withdrawn.

Removal of the Camshaft

This can be done only when the engine is removed from the chassis, and necessitates the removal of the bell housing.

The procedure for removal is this : Remove the tappets and bell housing and the cover over the front of the camshaft gearwheel. Unscrew the central setscrew, which is locked by a tab washer, and knock back the camshaft clear of the two dowel holes in the gear and remove the shaft from the rear. If the camshaft gear is to be removed, the front support bracket, which also serves as a cover providing access to this gear, must be removed, and the gear removed through the opening thus exposed.

Valve Adjustment and Timing, Pistons and Connecting Rods

Details are as for the 115-h.p. engine.

Crankshaft and Main Bearings

A seven-bearing crankshaft is fitted and the journals and the pins are hollowed out for lightness and also to allow the oil carried in the crank to assist the cooling of the bearings. These hollow portions of the crank are sealed by washers through which a clamping bolt is passed. Copper asbestos washers are placed under these washers and also under the bolt head and locking nut.

Whenever the crankshaft is removed these washers should be removed and the pins and journals thoroughly washed out. It is as well to

remember, too, that when reassembling the engine all the pins require to be filled with oil with a syringe to ensure that adequate lubrication takes place on the initial running until the oil pump begins to deliver oil.

To remove the crankshaft, the oil suction pipe must first be removed. The front bearing cap contains the oil pump. After this cap is removed the others should be taken away and the crank lifted bodily out.

The main bearings are of lead bronze in steel shells, and a clearance of ·004 in. to ·005 in. is allowed. The crankshaft is located endwise on the centre main bearing, and an end float of ·006 in. to ·008 in. is allowed.

The Fuel Pump and Drive

The fuel pump, as previously mentioned, is gear-driven from the idler wheel. A feature of the drive to the fuel pump is the provision that has been made to provide for slight misalignment of the fuel pump. Fig. 10 shows the cross-section through the gear and drive shaft, and reference to this illustration will show that the gearwheel is keyed to the shaft, which is mounted at its forward end on a self-aligning ball race. A fairly large clearance is allowed where the shaft passes through the casing at the back and an oil-return thread prevents the egress of oil from this point.

The Oil Pump and Lubrication System

The lubricating oil pump, which is of the gear type, is mounted in the front bearing cap and is driven from the crankshaft gearwheel. This pump is clearly illustrated in Fig. 11. An adjustment is provided for regulating the pressure, but this is provided purely for initial adjustment.

The oil under pressure is fed to the front main bearing through intercommunicating holes in the bearing cap itself, whilst the remaining six are fed through the oil-delivery pipe running beneath the main bearing caps clamped to each by means of keep plates. By this method of construction it has been possible to cut down the number of separate pipes and consequently the number of joints, so that the risk of bearing failure due to leakage has been eliminated. It is important, however, when replacing the oil-delivery pipe to see that the oil holes are clear and that it is well clamped down and the setscrews locked.

The connecting rods are lubricated via the hollow crank from the main bearings.

The idler gearwheel bearing is lubricated with full-pressure oil from the front main bearing.

Low-pressure oil is fed from the oil pump to the overhead-valve gear, from where it returns to the sump via the cast holes for the push-rods. This oil serves to lubricate the tappets and is caught in troughs which connect with the camshaft bearings.

This low-pressure oil is obtained from the pump in the following manner:

The spindle for the driven pump wheel is made hollow, with a small hole, which faces towards the delivery side of the pump, drilled racially through to the inside. A second small hole is drilled between two of the teeth of the driven pump wheel. The two holes are arranged to coincide once per revolution, and a small quantity of oil is thus forced into the interior of the spindle. By means of a copper pipe connected to the pump cover, oil is led up to the outside of the crankcase, where another pipe leads it to the top of the cylinders. From here it is led up round the cylinder head holding-down bolts to the rocker brackets and thus to the rocker gear.

The suction pipe draws oil from the rear of the sump through a gauze strainer.

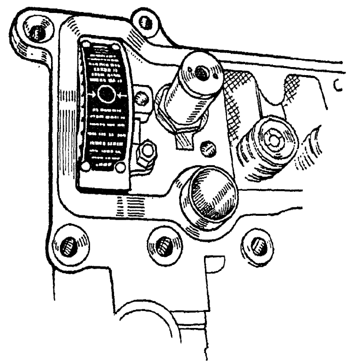


Fig. 14.—CAMSHAFT INDICATOR FOR RETIMING 4-CYLINDER ENGINE

When the forward piston is at top dead centre of the compression stroke, the line cut across the tops of the teeth of the timing wheel should come opposite to the two arrows, shown.

Water Pump and Fan Drive

Reference to Fig. 11 will show that the water pump and fan are mounted on a common spindle, and that they are belt-driven from a pulley on the front of the crankshaft. In common with all other designs of A.E.C. water pumps, a carbon or graphite gland prevents the leakage of water and obviates the necessity for constant repacking.

The pump can be removed as a unit with the fan by unscrewing the row of setscrews affixing it to the front of the crankcase and by removing the twin driving belts. The impeller is screwed on to the spindle and is locked by means of a nut on the end of the spindle. The impeller has a right-hand thread.

The ball and roller race on which the pump spindle is mounted is packed with grease, and should be lubricated with grease every week.

THE FOUR-CYLINDER ENGINE

The four-cylinder oil-engine is fitted with overhead valves operated by an overhead camshaft driven by means of a duplex roller chain and a pair of spiral gears. These latter are so arranged that it is possible to remove the head without breaking the chain.

The chain driving the camshaft also forms the drive to the fan, the water pump, the dynamo, the vacuum exhauster, and the fuel pump. These latter two are mounted in tandem on the nearside of the engine, whilst the water pump, which is mounted on the forward side of the crankcase, is driven by an extension of the dynamo drive shaft.

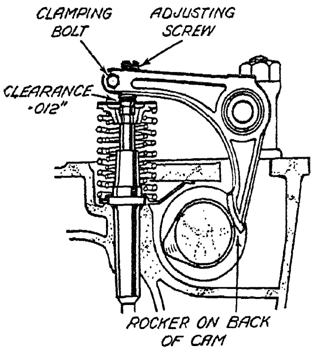


Fig. 15.—CAM POSITION WHEN

The Cylinder Head

The cylinder head carries the camshaft and valve gear.

The head is removable without breaking the chain. All heads are interchangeable, and where a fleet of vehicles fitted with this engine is being operated, it is recommended that a spare head be kept ready. This can then be dropped on to any engine without the vehicle being kept out of service for more than a couple of hours.

The Retiming Device

To enable the timing to be quickly and correctly picked up when the head is replaced, an indicator (*see* Fig. 14) is fitted to the timing wheel to show when the camshaft is in the position which corresponds with the forward piston at the top dead centre of the compression stroke. The camshaft indicator consists of a line cut across the tops of the teeth of the timing wheel, and arranged to come opposite to two arrows, placed one each side of a little window in the timing-wheel cover at the same time as the piston of the forward cylinder reaches its top dead centre, as indicated by the T.D.C.[1] mark on the flywheel.

Removal of Cylinder Head

Remove the cylinder-head cover and disconnect the top water pipe. It is generally easier to break the flanged joint on the cylinder head than to disturb the rubber connection.

Disconnect the exhaust-pipe flange, the copper bar connecting the heater plugs, and the fuel pipes to the injectors.

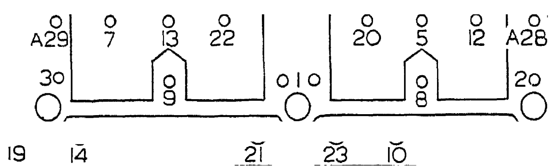


Fig. 16.—ORDER OF TIGHTENING CYLINDER-HEAD NUTS (FOUR-CYLINDER ENGINE)

Nuts marked A are jacknuts and should be lightly tightened down before any of the other nuts. They should be the last to be finally tightened. The four front nuts securing the head to the timing case should be only moderately tight. Over-tightening these may result in distortion of the aluminium timing case.

Remove the nuts which hold the rocker-shaft brackets in position, and lift off the two groups of rockers complete.

Two special jacknuts are fitted to facilitate the removal of the head, as described in connection with the 115-h.p. engine. These two nuts must not be unscrewed until all the other nuts, including the four which secure the timing case to the cylinder head, have been removed.

The seating angle for the valves is 45°.

Replacing the Cylinder Head

Lower the head carefully over the studs until it comes to rest on the jacknuts. These will hold it about ½ in. above the cylinder, and keep the timing-gear teeth just clear of each other.

Make sure that the timing mark on the flywheel is adjacent to the pointer, and that the timing line on the camshaft wheel is opposite the arrows. When timing for No. 1 cylinder, the line marked *L* on the fuel-pump coupling should be opposite the central line on the fuel-pump casing (*see* Fig. 22).

Keeping the head parallel with the cylinder, bring the two together by giving each jacknut alternately a few turns with the spanner.

Any resistance offered to screwing down the jacknuts will probably indicate that the gears are not meshing properly, and on no account must the nuts be forced home.

Examine the indicator to see that the line is opposite the arrows, and by feeling the camshaft timing wheel (the forward end of the timing-wheel cover is open), see if the wheel is free.

Wear in the chain will result in the timing line coming slightly below the arrows. The correct timing of the engine is :

Inlet valve opens	10° early.
,, ,, closes	38° late.
Exhaust valve opens	40° early.
,, ,, closes	8° late.

To give this timing the clearance for both valves should be ·008 in., and must be measured with the cam and rocker in the position shown in Fig. 15. The camshaft rotates in the opposite direction to that of the engine.

The nuts connecting the head to the timing case should not be tightened until all the others are home, and should be pulled up only moderately tight ; over-tightening these nuts may result in distortion of the aluminium timing case (*see* Fig. 16).

The tappet clearance must always be checked, because regrinding the valves will influence the adjustment. Before doing this make quite sure that the flat of the ball (*see* Fig. 15) in the end of each adjusting screw is bearing on the end of the valve stem.

Before running the engine after replacing the cylinder head, it is essential that all the air be removed from the fuel injector. Run the engine, and then give a further nip to all the cylinder-head nuts while it is still hot. The valve clearance should again be checked, as the valves may settle a little on their seats and so reduce the clearance slightly.

To remove the Camshaft

Remove the cylinder head as already described. Remove the covers at the front and rear end of the head. Beneath the rear cover, and carried in a cup, is the ball bearing. This need not be disturbed, as it will be withdrawn with the camshaft. Only the cover should be removed.

The front-valve cover stud serves also as the dowel for the front camshaft bearing, and this must be removed, together with the three setscrews locating the other bearings. Also remove the timing-wheel cover.

Drive down the turned-up edge of the timing-wheel nut-locking washer, and unscrew the nut. To prevent the camshaft from turning while unscrewing the nut, it should be jammed by inserting a piece of brass or aluminium about $\frac{1}{2}$ in. in diameter or thickness between one of the cams and the adjacent cylinder-head stud boss.

Placing a piece of brass or aluminium against the end of the camshaft, free the timing wheel from its seat with a smart blow from a hammer and thread the camshaft out of the cylinder head towards the *rear* end.

To remove the intermediate bearing, tap it gently with a light hammer to separate the two halves, which are dowelled together. Both this and the front camshaft bearings are made a slack fit on the shaft, the front bearing having a ·006-in. to ·008-in. clearance, and the intermediate bearing ·005-in. to ·006-in.

The ball bearing may be removed by unscrewing the nut at the rear end of the shaft, while to remove the front bearing remove the key from the tapered end of the shaft and the bearing may then be slipped off. To facilitate reassembling the timing wheel correctly, as soon as the camshaft bearing has been removed from the shaft, replace the screw which holds the key and thus identify the correct keyway.

Unless there is some special reason for doing so, it is as well not to remove the front bearing from the camshaft. It will not then be necessary to remove the key from the camshaft.

Replacing Camshaft

When replacing the camshaft, the only point which requires any attention is the replacement of the bearings into the head. The bearings are a push-fit in the head and are located by means of setscrews which act as dowels for this purpose. Care must, therefore, be taken to see

that the dowel holes in the bearings come opposite to the stud holes in the cylinder head.

The Connecting Rods and Bearings

The big-end bearings are as described for the 115-h.p. engine. They should on no account be fitted with a smaller clearance than from ·0045 in. to ·0055 in. It is extremely important that when replacing the bearings, the lead-bronze half is fitted in the connecting rod and not in the cap. The surface of the rod and cap must not be filed. End play between the rod and crank should be ·008 in. when new.

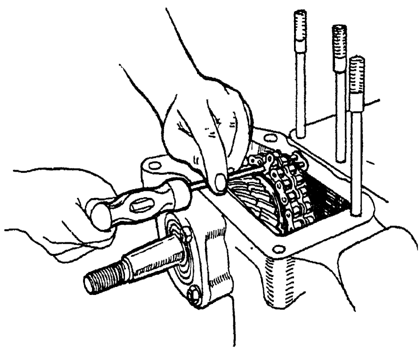


Fig. 17.—LINK BEING EXTRACTED FROM CHAIN PRIOR TO REMOVAL OF TIMING CASE

After extracting link, attach a length of wire to each end of the chain and hitch the free ends of the wires to one of the head studs.

The Pistons and Connecting Rods

Removal and fitting of these are as described in connection with the 115-h.p. engine, except that when new, the clearance of all the rings in their respective grooves is from ·0030 in. to ·0045 in., and the gap clearance of new rings should be ·008 in. when the ring is square in the cylinder. The clearance at the skirt of the piston, when new, is from ·010 in. to ·012 in.

To remove the Cylinder Block

After removing the cylinder head, remove the exhauster and fuel pump and take out the long bolt which passes through the water-inlet pipe, crankcase, and water-pump discharge. Disconnect the control rods from the hand-levers in the cab.

On removing the nuts which hold the block to the crankcase, the block can be lifted off. It is highly desirable that the pistons be drawn before the block is lifted.

The Timing Case

Mounted in the timing case is the auxiliary shaft which drives the exhauster and the fuel pump, and the fan shaft. The auxiliary and fan shafts are driven from the crankshaft by means of a duplex roller chain, which is kept at the correct tension by means of an automatic tensioner mounted in the crankcase. The final drive to the camshaft is by means of a pair of gears. The camshaft meshes with a pinion mounted on the fan spindle.

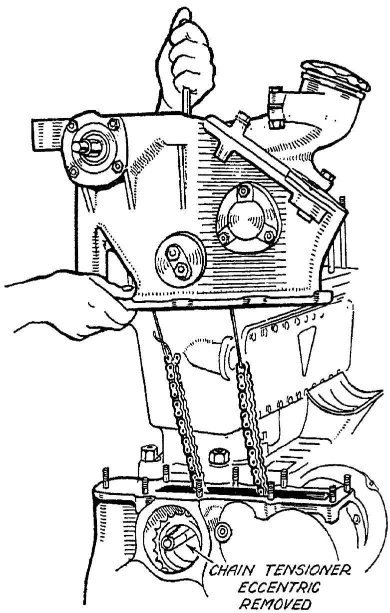


Fig. 18.—REMOVING TIMING CASE

Special provision is made to allow for any small variation in the mesh of the gears, such as may be introduced by the presence of the gasket between the cylinder head and the cylinder block.

The teeth of the two gears are cut somewhat deeper than a standard tooth, and being somewhat thinner on the pitch line, binding is prevented if the centres are not dead accurate.

To eliminate the backlash that this method may produce, the pinion (Fig. 19) is made in two parts, one of which is fixed to the fan sprocket and actually drives the camshaft. The other is free to turn on the spindle through a small angle. A turning motion, in a direction opposite to that in which the whole pinion rotates, is produced by springs, a stop being fitted to limit the motion to an amount of about one-quarter of a tooth thickness.

When disengaged from the camshaft gear, the teeth on the two parts of the pinion are thus brought out of alignment with each other and give much the same effect as that of a thick tooth. As the moving part is spring-loaded, the thickness of the tooth is capable of variation and will thus adjust itself automatically to the space available between the teeth of the timing gear, and, by virtue of the two parts of the pinion bearing against the timing wheel in opposite directions, will eliminate any backlash and its accompanying noise.

To remove the Timing Case

To remove the timing case the radiator must first be removed. Extract chain link as shown in Fig. 17, and to each end of the chain connect a length of copper or soft-iron wire, and hitch the free ends of the wire to one of the head studs.

Remove the nuts holding the case to the crankcase, and lift off the timing case, allowing the chain to slip through. The wires will prevent it from dropping into the crankcase. Pull the wires through the case and rehitch them to the head stud (Fig. 18).

To remove the Dynamo and Water-pump Drive Shaft

Remove the water pump by unscrewing the large nut on the nearside of the pump and lift it off. (The long bolt through the water con-

nections, which has already been removed, also serves to hold the pump on.) Remove the generator coupling and the cover behind it, take out the key, and drive the auxiliary shaft out towards the front of the engine. The sprocket wheel, the ball bearing at the generator end, and the oil-thrower disc will be stripped off, while the bearing at the water-pump end, together with its oil-throwing disc, will probably remain on the shaft.

It is quite unnecessary to remove the auxiliary shaft unless the sprocket or one of the ball bearings becomes worn and requires renewal. Except in some such case it should be left undisturbed.

To remove the Fan Spindle, Camshaft Pinion, etc.

Remove the fan, using the draw-dog supplied in the tool-kit. Remove the front-bearing housing complete with bearing. Remove the rear cover and drive out the spindle towards the *rear* of the timing case. The camshaft pinion and fan sprocket will be stripped off as a unit, and should be kept as such and never taken apart unless it is necessary to renew one or the other. The bearing will come away with the spindle.

To remove the Chain Tensioner

Remove the large cover on front of crankcase. Release the spring by freeing the outer end from the slot into which it is hooked. (Use a screwdriver and be careful, or torn fingers may result.) The eccentric complete may then be pulled off.

When removing the tensioner while the timing case and chain are in position, the sprocket will be stripped off the eccentric as the latter is removed, and will remain hanging on the tensioner spindle (Fig. 18).

To replace the Chain when Reassembling Timing Case on Engine

Remove the oil filler from the timing case, remove the chain tensioner. Pass the wire which is attached to the nearside end of the chain up through the timing case, round the inside of the auxiliary sprocket, and out of the oil-filler opening, and make it fast to a convenient stud.

Pass the wire connected to the offside end of the chain up through the timing case so that it will pass up out of the top of the case on the offside of the fan sprocket. Place the timing case in position on the crankcase and bolt it down. Make sure that the paper gasket between the crankcase and timing case is in good condition.

Draw the chain up with the wires, pulling the nearside end out of the oil-filler opening.

Pass the nearside end wire back through the oil-filler opening and out at the top on the nearside of the fan sprocket, and draw the chain through and connect up temporarily by inserting the pins only.

Place the tensioner sprocket in position over the spindle and engage the teeth with the chain, then fit the eccentric into the sprocket and turn

the eccentric in a clockwise direction as far as it will go, and replace the ratchet.

The chain must be engaged with the fan sprocket so that when pistons of the front and rear cylinders are on the top dead centres, the line scribed on the back of the sprocket is parallel with the top of the timing case.

If the sump is off, this may be easily done by placing the crankshaft in the required position before starting, and engaging the chain with the crankshaft sprocket in such a way that the joint comes at the top of the timing case.

If the sump has not been removed, the chain must be temporarily connected and the crank brought to the required position. Then note the number of teeth and the direction in which the fan sprocket must be moved to bring the line parallel with the top of the case, break the chain again and move the sprocket the amount and direction already determined. Wear in the chain will cause a slight departure from the true parallel and cause the line to dip slightly towards the offside.

After being satisfied that the engagement of the sprocket and chain is correct, replace the spring of the tensioner and wind up the spring as explained later. The fuel pump must, of course, be retimed before starting up.

Replacing the Chain

To replace a chain which is too worn for further service, remove the radiator, the cylinder head, and the cover over the chain tensioner. Release the tension on the spring of the tensioner and remove both the spring and the ratchet. Break the chain and connect the new chain to the nearside end of the old one. Put a good tension on both ends of the chain. Keep the offside end in mesh with the fan sprocket, and have the engine cranked slowly round until the whole of the old chain has been fed out of the timing case and the new one wraps on the fan sprocket. Disconnect the old chain from the new and connect the ends of the new one together. If carefully done, both the mesh of the chain with the fan sprocket and the fuel-pump timing will be correct, but must be checked.

To obtain the Correct Chain Tension

Turn the chain-tensioner eccentric as far as it will go in a clockwise direction, replace the ratchet with its slotted cover plate outwards, and engage the pin in the eccentric in the slot. Engage the tongue in the centre of the spring with the slot in the chain-tensioner spindle, and wind up two and one-half turns in a counter-clockwise direction and hook the end into one of the four slots provided for it in the outer edge of the eccentric.

To assemble the Camshaft Pinion

If the camshaft pinion has been taken apart, particular care must be exercised to see that it is reassembled correctly, not only as regards the relative position of the teeth of the two parts, but also as to the direction in which the moving part has freedom of motion.

To enable the correct relative position to be regained without difficulty, a small punch-mark is placed on two of the teeth, and the pinion must be assembled with the marked teeth together. The pinion will then have the correct amount of offset in the teeth, and also freedom of motion in the required direction.

If there is any doubt as to the marking, the correct engagement may be determined as follows:

Hold the fixed part of the pinion with the boss uppermost and with one of the four pins in the recess directly towards you. Place the moving part with the pins downwards on to the boss of the fixed part. Then engage the pins of the moving part on the *right* of those of the fixed part. Afterwards turn the moving part to the *left* to bring the two sets of pins into contact with each other. When correctly engaged, the two sets of teeth must be about one-quarter of a tooth thickness out of alignment, and the teeth of the moving part must be on the *left* of those of the fixed part.

The pinion has four pins and twenty-one teeth, and four

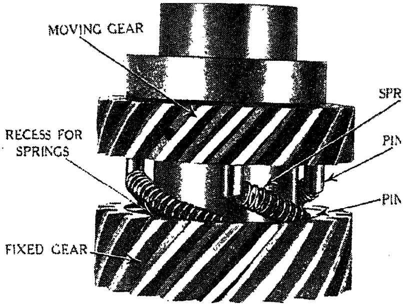


Fig. 19.—CAMSHAFT PINION OPENED OUT TO SHOW ACTION OF THE SPRINGS

A turning motion in a direction opposite to that in which the whole pinion operates is produced by the springs. By these means, the thickness of the pinion teeth adjusts itself automatically to the space available between the teeth of the timing gear, thus eliminating backlash and noise.

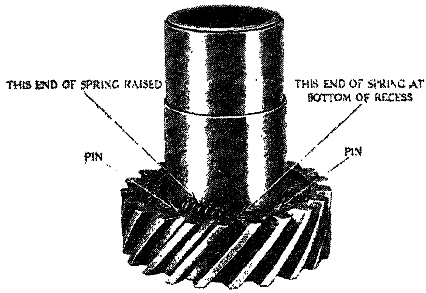


Fig. 20.—CAMSHAFT PINION. SPRINGS INSERTED

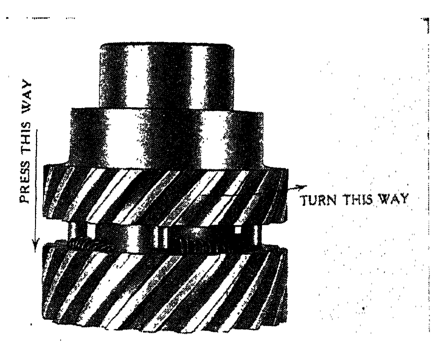


Fig. 21.—ASSEMBLING CAMSHAFT PINION

different settings can therefore be obtained which vary a quarter of a pitch from each other. The correct position can therefore be easily picked out. When correctly assembled, a slight turn of the moving part to the right will bring the teeth into line. Mark a pair of teeth adjacent to one of the pins before separating the parts to insert the springs.

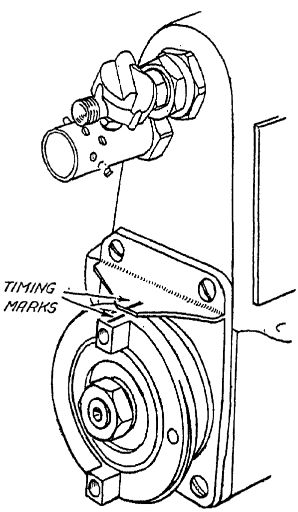
To insert the Springs

Hold the fixed part with the boss uppermost and insert the springs into the recess with their right-hand ends at the bottom of the recess, and against the pins but with the end coil of the left-hand end of the spring only just caught on the pins (*see* Fig. 19), and standing as far as possible out of the recess. The springs will then form a spiral in the opposite direction to that of the teeth (*see* Fig. 21).

Place the moving part over the boss and bring the pins of the two parts end to end (*see* Fig. 21), taking care to arrange them so that they are in the same relation as when the teeth were marked, and, holding the fixed part firmly, twist the moving part to the *right* to compress the springs and at the same time press the two parts towards each other. The parts will then come together, and if the instructions have been carefully followed, will be in the proper relationship with each other.

Timing the Fuel Pump

If the fuel pump only has been removed from the engine, the coupling must be re-engaged so that the letter O marked on each of the parts of the coupling come opposite each other. The correct timing will then be picked up automatically.



g. 22.—Timing mark on fuel pump coupling

Timing marks are provided on the flywheel to facilitate retiming the fuel pump in cases where the chain has been disconnected.

The fuel pump rotates in the opposite direction to the crankshaft. The pumps themselves are provided with two timing marks, one for each direction of rotation and marked *R* and *L*. *That marked L is the one which must be used.*

To time the pump, turn the crankshaft so that the pointer is opposite to the T.D.C. mark on the flywheel when No. 1 cylinder (the forward one) is on compression stroke and then couple up the fuel pump so that the *line marked L on the coupling* is opposite the centre line cut on the end of the fuel-pump casing.

THE MORRIS EIGHT ENGINE, CLUTCH, AND GEARBOX

SERIES E

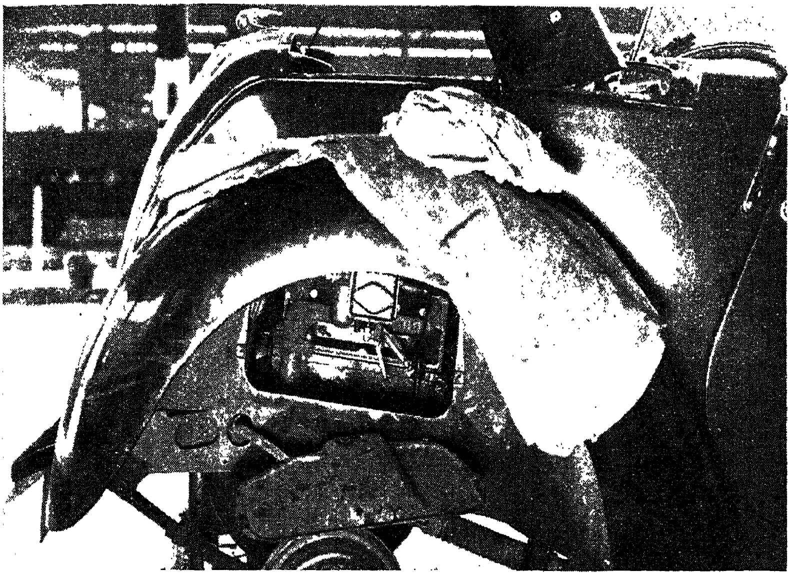


Fig. 1.—A SPECIAL DETACHABLE PANEL IS PROVIDED IN THE NEARSIDE WING VALANCE TO GIVE EASY ACCESS TO THE MAIN ENGINE COMPONENTS

The panel is shown removed. The photographs in this article were taken in the Acton repair depot of Stewart & Ardern, Ltd.

ALTHOUGH it would appear on first sight that the latest addition to the Morris Eight series presents difficulties of access owing to its unusual design, closer inspection and actual experience clearly indicate that this is not the case, the latest model showing many points of superiority over the older models.

In order to give easy access to the main engine components such as the carburettor, manifolds, valve gear, etc., a special detachable panel has been provided in the nearside wing valance which, when removed, together with the nearside wheel, enables attention to be given to all components on the nearside of the engine with ease. This aperture in the valance is also of great help when carrying out major repair operations or decarbonising.

Routine attention and adjustments are fully detailed in the Morris manual dealing with this model, which is issued with every car, and in this section it is proposed to deal only with the additional points needed by the repairer.

Decarbonising and Valve Grinding

Decarbonising and valve grinding are items of attention which the repairer is most frequently called upon to execute, and although on the Morris Eight (Series E) this attention is quite straightforward, there are, nevertheless, several special features of the engine which need special knowledge and consideration.

Dismantling Procedure

The following is the recommended procedure when dealing with these items.

First of all raise the hinged bonnet and, as a precautionary measure, tie it in the open position with a piece of stout cord to a convenient part of the car. The water should then be drained from the cooling system through the drain tap fitted on the nearside of the radiator bottom tank.

Proceed to disconnect the positive cable from the battery by slackening the pinch bolt of the terminal lug and withdrawing the lug from the terminal post.

The next step is to release the clips from the upper radiator hose connection, and free the hose from the cylinder head and radiator pipes.

The low-tension wire should be released from its terminal on the distributor body and the fan-belt tension released by slackening and removing the ¼-in. tension-adjusting bolt and its steel washer. This will enable you to remove the belt from the fan pulley.

If the two bolts attaching the dynamo to its cradle on the cylinder head are now removed, it will enable the dynamo to be withdrawn and deposited in the tool tray without disturbing any of the wiring.

The high-tension wires should now be disconnected from the sparking plugs and from the spark coil, after which the lock-wire can be removed from the dowel bolt, attaching the distributor clamp plate to the cylinder head, enabling the clamp bolt to be withdrawn, so that the distributor assembly can be removed from the cylinder-head tunnel. It is to be noted that it is unnecessary to disturb the pinch bolt on the clamp plate, and that if it is left undisturbed there will be no difficulty in attaining the same ignition setting on reassembly.

A bracket for the throttle control is provided on the cylinder head, and should be released by unscrewing its retaining setscrew. Do not lose the shakeproof washer.

Release also the throttle control from its attachment to the carburettor-throttle lever by slackening the nut of the clamp bolt.

The air-silencer assembly should now be removed by unscrewing the

bracket bolt and slackening the screw of the intake pipe clip. This will enable the curved intake pipe to be removed after its two attachment screws to the carburettor flange have been removed, not forgetting to release the throttle return spring first.

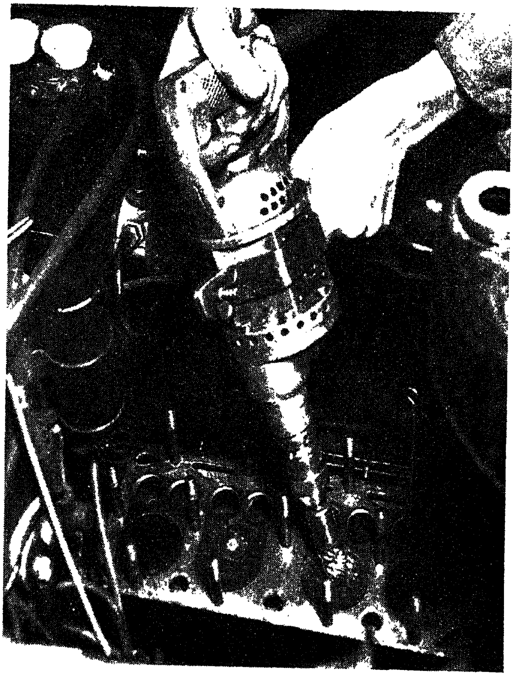


Fig. 2.—REMOVING CARBON DEPOSIT FROM PISTONS

Removing Cylinder Head

The cylinder head itself may now be released by slackening each of the thirteen stud nuts a partial turn at a time in rotation until they are all quite free. Do not attempt to hurry this procedure by slackening each nut at a time completely, or you may distort the head from the uneven pressure. Note that the engine earthing-cable terminal is located under the rear nut.

When you have completely removed all the stud nuts, you may withdraw the head, breaking the joint by smartly turning the engine with the starting-handle, or giving it light blows with a hammer, interposing a piece of wood to take the blow.

When the head is removed, the distributor-drive spindle may be withdrawn from its housing.

At this stage it is advisable to jack up the nearside front wheel and place a suitable solid stand under the axle, to prevent any possibility of accident during subsequent operations.

Removing Manifold

Remove the panel in the wing valance by undoing its retaining screws. This will give access to the carburettor, enabling you to release the mixture control from the jet-actuating arm, and also enable you to release the carburettor from the manifold.

Undo the two bolts attaching the exhaust-pipe flange to the manifold,

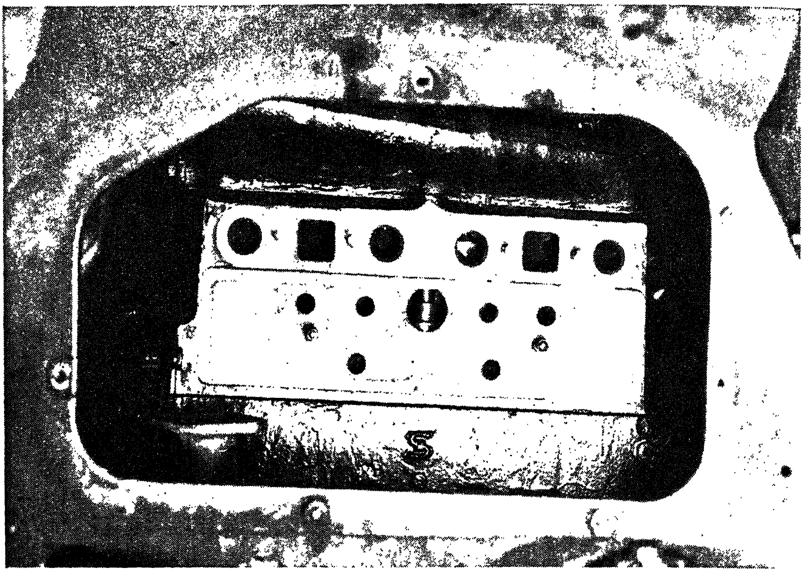


Fig. 3.—GASKET OF VALVE COVER IN POSITION, WITH TWO HOLES AT BOTTOM

making note that the joint is sealed with a copper-asbestos washer. The manifold can now be removed by unscrewing the four long-bodied hexagon nuts from the retaining studs.

The carbon deposits should now be removed from the piston crowns, using a rotary wire brush in an electric drill, or failing this equipment with a blunt screwdriver or similar tool. Take care not to damage the crowns of the pistons, as they are readily scratched.

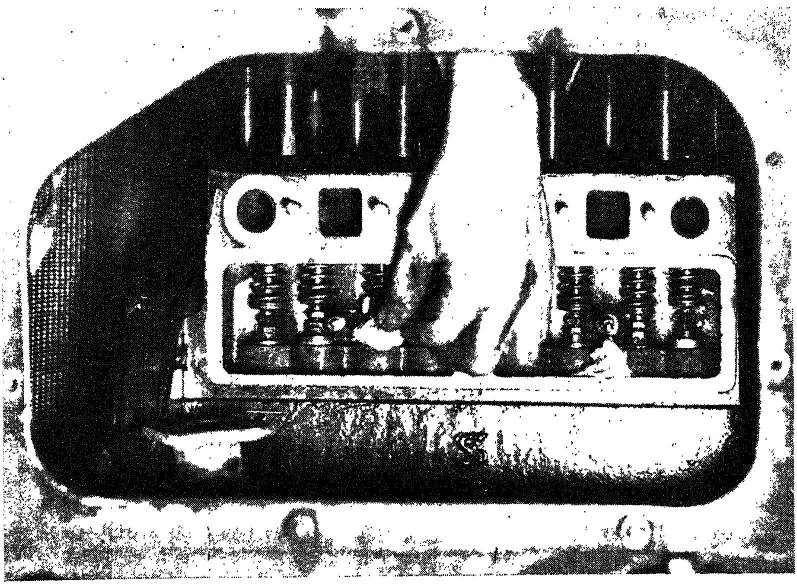
Remove, also, the traces of carbon deposit on the top face of the cylinder head and round the valves and any deposits on the valve heads.

The carbon deposits should also be carefully cleaned from the combustion chambers in the cylinder head, after removing the plugs, so that no deposits find their way into the plug interiors.

Access to Valves for Removal

Attention may now be given to the valves, which generally need grinding attention at the decarbonising period.

To obtain access to the valves it is necessary to remove the valve-chamber cover from the nearside of the engine. This is achieved by slackening the bolt of the clip attaching the fume-exhaust pipe to the cover and removing the bolt locating the pipe-support bracket to the clutch housing, thus enabling the fume pipe to be removed. The two wing nuts holding the valve cover in position may now be removed, taking care of the fibre washers under these nuts, which will enable the



g. 4.—BEFORE REMOVING VALVES, PLUG THE HOLES IN FLOOR OF VALVE CHAMBER WITH RAG

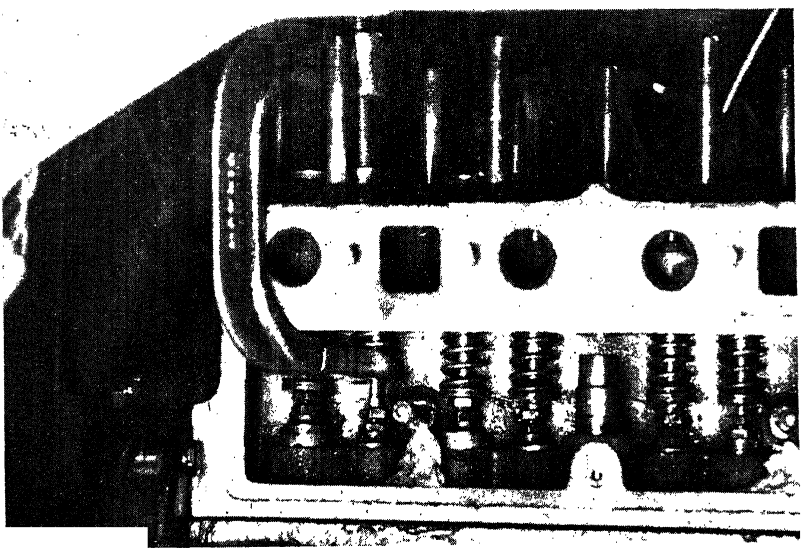


Fig. 5.—VALVE REMOVAL

Showing use of C-type compressor for springs.

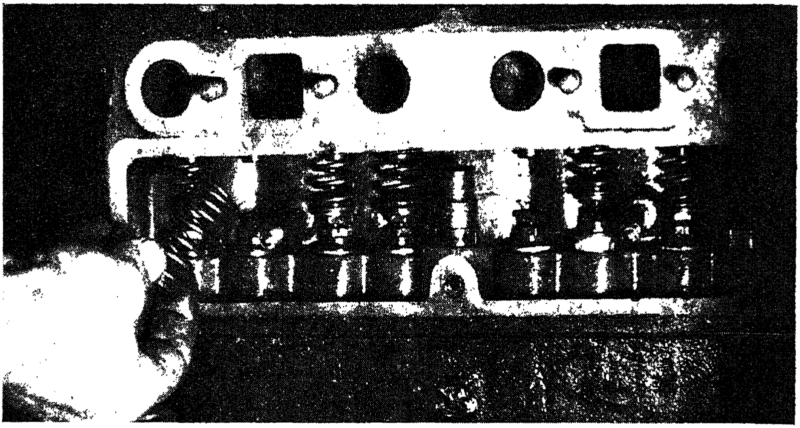


Fig. 6.—REFITTING VALVE SPRINGS

Take care to see that the close coiled end of each spring is at the top.

cover to be withdrawn. Under the valve cover will be found a sealing gasket with two small holes, and it should be noted that these holes are at the bottom on reassembly. Withdraw this gasket from the valve chamber and studs.

Before removing the valves it is advisable to plug the two holes in the floor of the valve chamber with clean rag, in case any of the valve cotters are dropped during removal, as they would fall into the crankcase, entailing additional work in their removal.

The valves should preferably be removed by using a C-type compressor for the springs, and a suitable tool is marketed by Morris Motors under Part No. 38378. See that the foot of the tool properly embraces the spring cap before tightening up the compressing screw.

When the spring cap is clear of the cotters the latter may be withdrawn from the groove in the valve stem, releasing the spring cap, the spring, and finally the valve itself.

When refitting Valve Springs

It is to be noted that the valve springs on this model are of the progressive-pitch type, with the pitch of the coils increasing towards the valve cap. When refitting the springs it is therefore important that they should be refitted with the close-coiled end upwards, making contact with the top of the valve chamber.

The valves are numbered on their heads to correspond with their ports, No. 1 port being at the forward end of the engine, of course, and they should always be retained in the same port for grinding and refitting.

Grinding Valves

When the valves are removed they should be carefully examined for pitting, and any blemishes of this nature should be removed with a special grinding machine or with the valve-refacing tool obtainable from Morris Motors Spare Parts Department under Part No. 65925. When grinding the valves, remember to remove only just enough metal to obliterate the blemishes and no more; excessive grinding is wasteful.

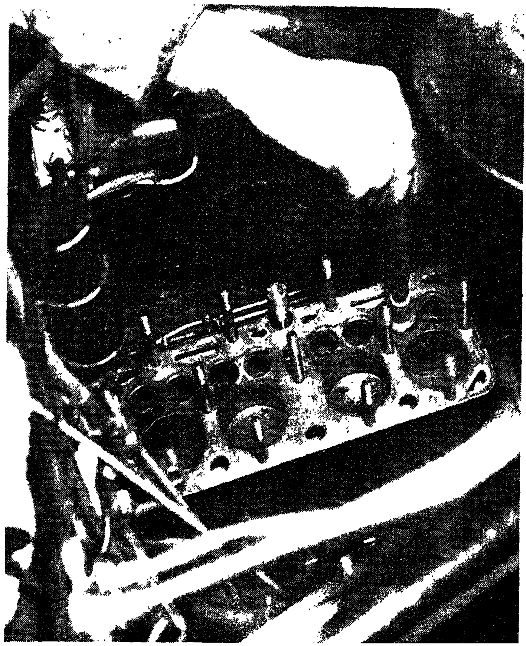


Fig. 7.—GRINDING IN VALVE WITH SPECIAL TOOL No. 65925

As the valve heads are quite plain, a suction-type tool is needed.

The valve heads are quite plain, and have no provision for the insertion of a valve-grinding tool. A special suction-type tool is therefore needed, and this also is obtainable from Morris Motors Ltd. for a modest sum under Part No. 66893.

The valve face should be lightly smeared with grinding paste, reinserted in its port, and reciprocated on its seat with the suction tool, raising it occasionally and returning it in a fresh position to obviate the formation of annular grooves.

As soon as an even matt surface appears on both the face of the seating and the valve, cease grinding, as you will then know that the valve is seating properly over the whole of its working face, and there is no point in further grinding.

When grinding in the valves, make sure that they are seating properly and not resting on the tappet heads. To guard against this it is advisable to slacken back the tappet screws in the tappets to give ample clearance for all eventualities.

After grinding, each valve must carefully be washed in paraffin to remove all trace of the grinding paste, and the valve seating in the cylinder block must also thoroughly be cleaned with a clean rag damped in petrol. Avoid swilling out the port with petrol, as this will carry some of the grinding paste into the working parts of the engine to their detriment.

When valves and ports are thoroughly clean, the valves may be replaced, together with their springs, cotters, and spring caps, keeping them in their correct ports, and using the valve-spring compressing tool to control the springs during cotter replacement.

Setting Valve Clearances

The valve clearances should now be set, as the grinding operation removes a certain amount of metal, causing a modification to the tappet clearance. The correct clearance is ·017 with the engine warm or ·018 with the engine cold, and this *must* be set with the back of the cam exactly in line with the tappet, owing to the special form of cam contour used.

To facilitate this, use should be made of the following table, which saves unnecessary engine turning at the same time.

Adjust No. 1 tappet with No. 8 valve fully open.
Adjust No. 3 tappet with No. 6 valve fully open.
Adjust No. 5 tappet with No. 4 valve fully open.
Adjust No. 2 tappet with No. 7 valve fully open.
Adjust No. 8 tappet with No. 1 valve fully open.
Adjust No. 6 tappet with No. 3 valve fully open.
Adjust No. 4 tappet with No. 5 valve fully open.
Adjust No. 7 tappet with No. 2 valve fully open.

The sparking plugs should be cleaned, adjusted, and replaced in the cylinder head, which is then ready for refitting.

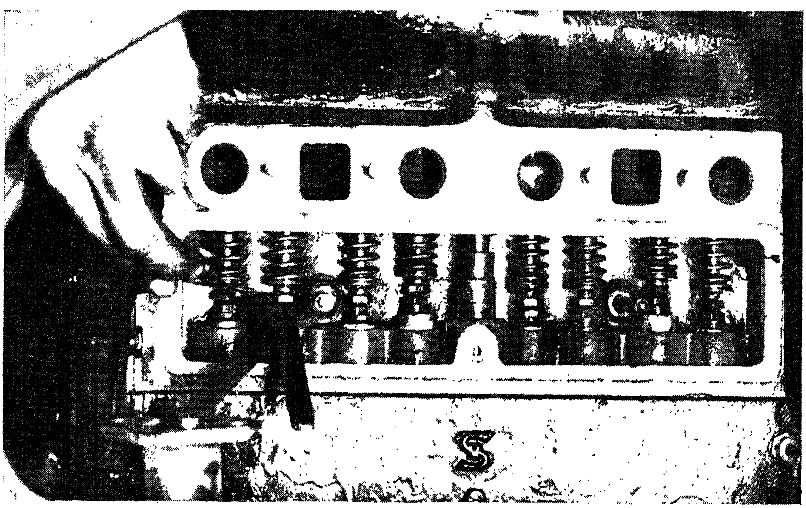
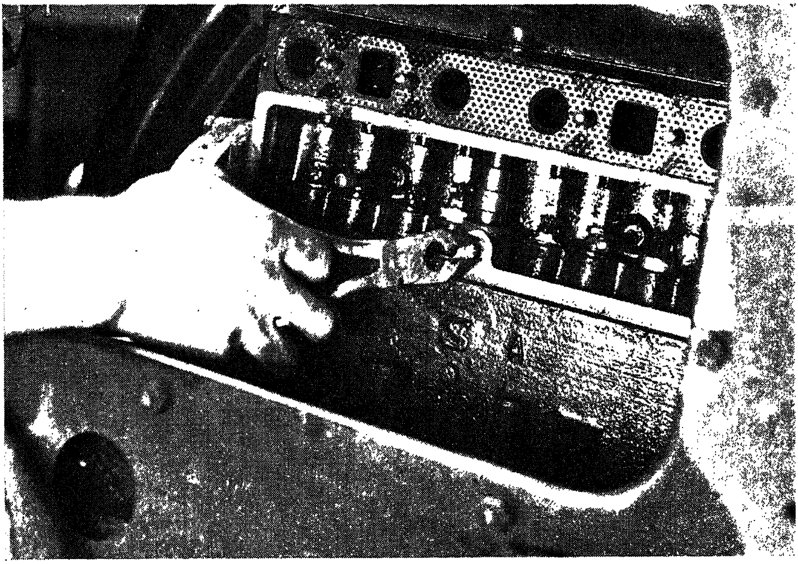


Fig. 8.—TAPPET ADJUSTMENT



9.—Removing dowel which holds distributor drive in position

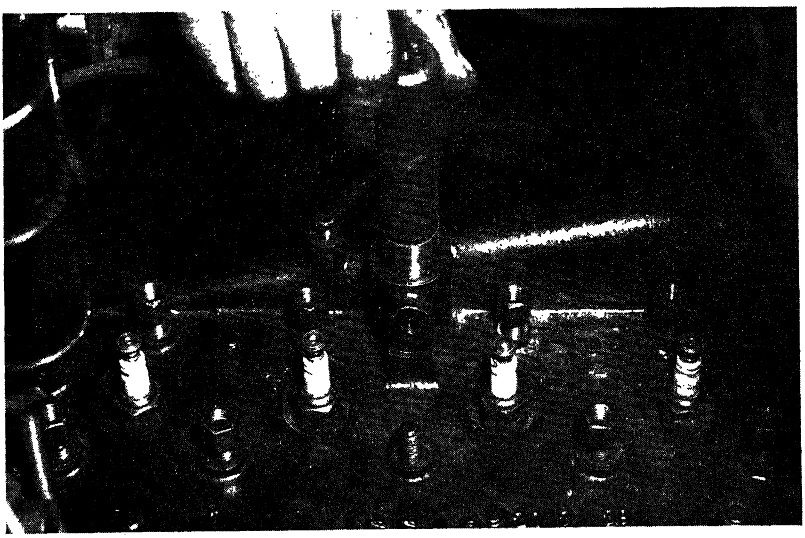
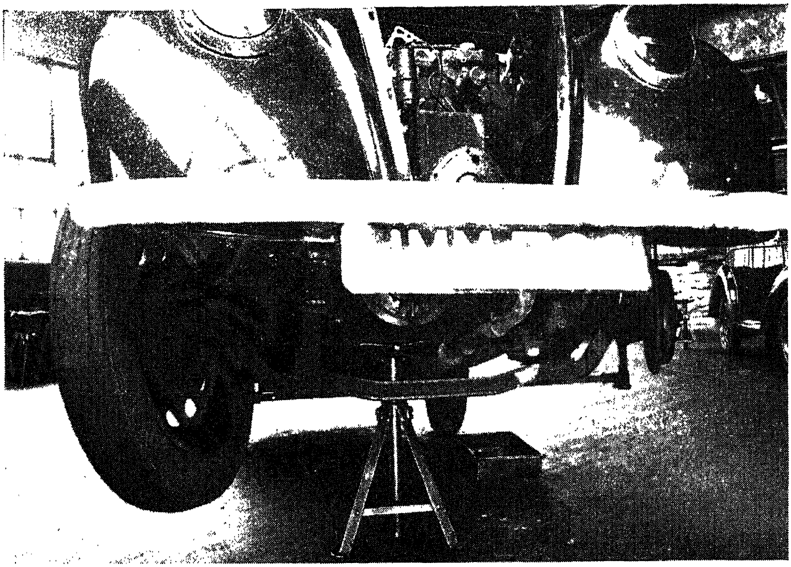


Fig. 10.—Replacing cylinder head

Locating the distributor drive tunnel with alignment tool No. 39387.



ig. 11.—HOW CAR SHOULD BE HELD UP TO FACILITATE REMOVAL OF SUMP

Replacing Cylinder Head

The cylinder-head gasket should be examined for damage, and if found in good order it can be used again, employing a little jointing compound to ensure a sound joint. If the gasket is in any way damaged, fit a new one. A new gasket does not need jointing compound to ensure a sound joint and should be fitted dry.

When replacing the gasket, guide it carefully over the cylinder-head studs to avoid damage.

With the gasket properly positioned the head may be placed in position, but before any of the cylinder-head stud nuts are replaced it is essential to locate the head properly so that the distributor may be replaced. To facilitate this Morris Motors offer a special alignment tool Part No. 39387. This tool is adapted to engage the distributor shaft tunnel in the cylinder head and the cylinder block, ensuring their proper coincidence.

Replace the cylinder-head stud nuts and tighten them up a half turn at a time in rotation until they are all quite tight, starting with the five nuts in the centre row.

The remainder of the components are replaced in the inverse order to their removal and should present no difficulty.

When all controls have been connected up the engine should be started up and allowed to run until thoroughly warm, when the cylinder-head stud nuts should be given a final tightening.

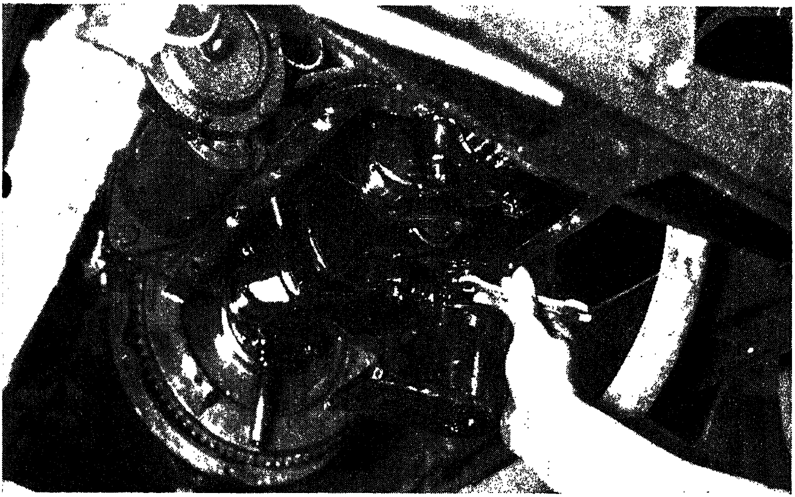


Fig. 12.—REMOVING OIL PUMP

Unscrew the two bolts that attach the pump to the underface of the crankcase. Draw the pump downwards.

Removal of Engine Oil Sump

Move the car on to a ramp or over an inspection pit, or failing this equipment raise the front of the car on a hoist.

The sump is attached to the cylinder block by twelve bolts which all have $\frac{1}{4}$-in. hexagon heads except the two forward ones and two rear ones which possess $\frac{3}{16}$-in. hexagon heads only.

Ten of the bolts are inserted into the sump flange from below, the remaining two being inserted from above on either side of the oil-pump housing.

In order to provide ample clearance for sump removal it is advisable

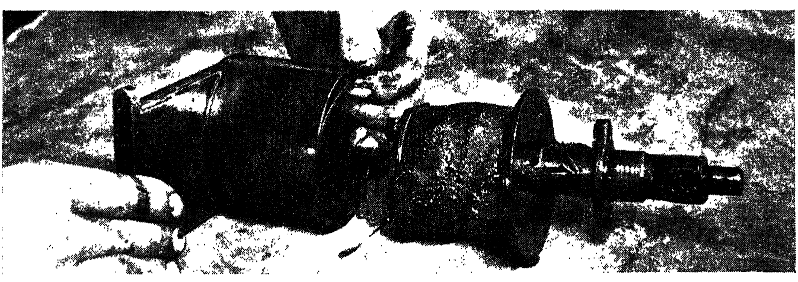


Fig. 13.—REMOVING FIBRE GASKET SITUATED BETWEEN PUMP HOOD AND BODY

If this is damaged, it should be replaced by a new one.

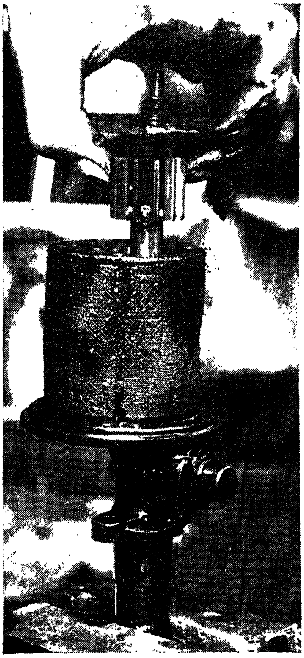


Fig. 14.—REMOVING OIL PUMP GEARS



Fig. 15.—REMOVING LOCKING WIRE FROM RELIEF VALVE

to raise the front end of the car until the entire weight of the axle is on the springs.

Sump removal presents little difficulty, but on replacement special care must be taken to see that the sump gasket is fitting properly and that the cork seat for the rear main-bearing cap is in order and properly fitted to ensure an oil-tight joint between the sump and the clutch housing.

Oil-pump Assembly, Removal, and Dismantling

The oil-pump assembly is removed by withdrawing the two bolts which attach the pump to the under face of the crankcase and drawing the pump downwards. It is to be noted that this does not interfere with the ignition timing.

The hood surrounding the pump is released by extracting the split pin from the fixing stud at the bottom of the pump and removing the plain, double-coil spring and fibre washers.

Situated between the hood and the pump body is a fibre gasket which should carefully be preserved. If it is in any way damaged it should be replaced by a new one.

To obtain access to the pump gears the four screws holding the pump base in position should be withdrawn, releasing the base. Removal of the filter gauze permits withdrawal of the gears from the pump body.

The relief valve is mounted on the pump-spindle housing and can be removed after extracting the lock wire by unscrewing the relief-valve plug which also releases the spring, spring pad, and sealing ball.

When rebuilding the pump it is essential to notice that the pump hood possesses a locating slot which should face to the nearside of the engine and is assembled with its intake facing the offside of the engine and at right angles to the crankshaft centre line.

When introducing the pump assembly into the pump tunnel make sure that the slot in the pump-drive spindle is in proper engagement with the tongue on the camshaft-drive gear. This tongue is not offset as is the case in the distributor drive, as no timing problems are involved.

Removing the Engine

The engine may be removed from the car when it is in need of extensive attention quite easily, either without disturbing the gearbox or as a complete unit with the gearbox.

Dealing first with the removal of the engine alone, leaving the gearbox in the car, the following procedure is advised.

Open the bonnet and fasten it in the open position for safety. It is unnecessary to remove it.

Drain the water from the cooling system by means of the drain tap situated in the nearside of the bottom tank of the radiator.

Removing Radiator Shell

Remove the radiator shell by undoing the two countersunk-headed screws and nuts locating the shell to the radiator core, and removing the packing strip from under the bonnet webbing. Removal of the ten setscrews attaching the radiator shell to the wing valances permits withdrawal of the shell unit.

Unscrew the pinch-bolts of the hose clips on both top and bottom hoses, and release the hoses from their connections.

Release the two radiator-attachment studs which pass through the front chassis cross-member, by removing the nuts and locknuts, thus enabling you to remove the radiator, which should now be stored in a safe place.

The battery should now be disconnected by releasing the clamp-screw of the positive-cable lug from the battery terminal post, in order to avoid the possibility of an accidental short-circuit.

Remove the air silencer as a unit with the air-intake pipe by releasing the silencer from its support bracket and withdrawing the two setscrews attaching the air-intake pipe to the carburettor body, not forgetting to release the throttle return spring from the air-intake pipe.

The throttle and mixture controls should be disconnected from their attachment to the carburettor, and the throttle-control cable should be released from the steady bracket attaching it to the cylinder head.

Release of the petrol pipe at its junction to the petrol pump will now enable the carburettor to be withdrawn from the inlet and exhaust manifold when its two attachment nuts have been unscrewed.

The high-tension cable between the coil and the distributor should be released from the coil, and the low-tension distributor connection should be released from its distributor terminal.

If the dynamo is not in need of attention it may be detached from the cylinder-head cradle by undoing and removing its three attachment bolts, and be placed in the toolbox on the dash as for decarbonising. Should the dynamo be in need of overhaul it may be left on the engine till a later period, in which case the two leads should be detached from the dynamo, taking note that the yellow-coloured lead is attached to the terminal on the offside.

The starter cable should be detached from the terminal on the starter switch located on the scuttle dash, and the earth cable should also be detached from its attachment to the cylinder head.

Release the oil-gauge pipe from its connection to the cylinder block, and release the exhaust pipe from the manifold flange by removing the two attachment bolts, carefully removing the flange gasket.

Transfer your attention to the inside of the car, and remove the front mat by withdrawing the retaining press-pins. Now remove the nearside front seat by undoing the wingnuts clamping it to the car floor, and the offside seat by releasing its adjustment catch and sliding the seat forward until clear of the guides.

Remove the knob from the gear lever after slackening the locknut which fastens it in position. This will enable you to withdraw the rubber gearbox cover with ease, passing it over the lever.

The two front floorboards should now be removed by releasing the twelve countersunk-headed screws attaching them in place, and the two round-headed screws attaching the headlamp-dipping switch in place.

To prevent Gearbox falling when removing Engine

In order to prevent the gearbox from falling when it is released from the engine, it is recommended that a wooden wedge he inserted between the propeller-shaft tunnel and the propeller shaft, to take the weight of the gearbox. To prevent straining of the gearbox mounting it is advisable to slacken off the nuts on the flexible mountings studs passing through the frame cross-member—four or five turns are sufficient.

The weight of the engine should now be supported on suitable lifting tackle, keeping the engine as nearly in balance as possible. If a lifting ring is employed in connection with the lifting hoist, it should be screwed into No. 3 sparking-plug hole.

You may now release the clutch housing from the flywheel housing by undoing the series of screw bolts fastening the two together, releasing the rear of the engine.

The forward end of the engine should next be released by removing the nuts retaining the forward engine-bearer bolts to the engine mountings.

The engine may now be raised by means of the tackle, and moved forwards until clear of the car.

Removing the Engine and Gearbox as a Unit

The procedure for removing the engine and gearbox as a complete unit presents no special difficulty, and the preliminary dismantling is precisely the same as that described for removing the engine alone, with the exception that the speedometer cable must be released from the gearbox in addition, also the gearbox earth cable must be disconnected from the gearbox, replacing the nut before it is lost.

The clutch-actuating chain must also be released from the clutch-actuating arm by removing its clevis-pin attachment, and the gearbox cover complete with gear lever should be removed, placing a temporary cover in position to prevent the entry of dirt.

The flexible mountings for the gearbox should be completely released from the frame cross-member, and the brackets removed.

The four bolts attaching the two halves of the universal-joint flange should also be removed, releasing the engine and gearbox for removal in a forward and upward direction, after the front engine mounting has been released.

Dismantling the Engine for Overhaul

When the engine has been withdrawn from the car it should preferably be placed on a suitable engine stand for further attention.

If the engine and gearbox have been removed as a unit, you may part the two at this stage to give access to the clutch assembly. This is done, of course, by removing the seven bolts attaching the two together.

The clutch pressure-plate assembly may then be removed if desired by unscrewing the six setscrews spaced round the rim, taking care to undo them only a fraction of a turn at a time in rotation so as to avoid bending the clutch cover plate. When the screws are quite free you can complete their removal and withdraw the clutch pressure-plate assembly, which also releases the driven plate.

It should here be noted that it is essential to use a proper clutch-alignment tool when reassembling the clutch, to ensure concentricity of the components, or it will be found impossible to insert the forward end of the gearbox shaft. Full details concerning the proper methods of clutch assembly are given in the section of this publication dealing with the Borg and Beck clutch.

Disconnect at this stage the high-tension leads from the sparking

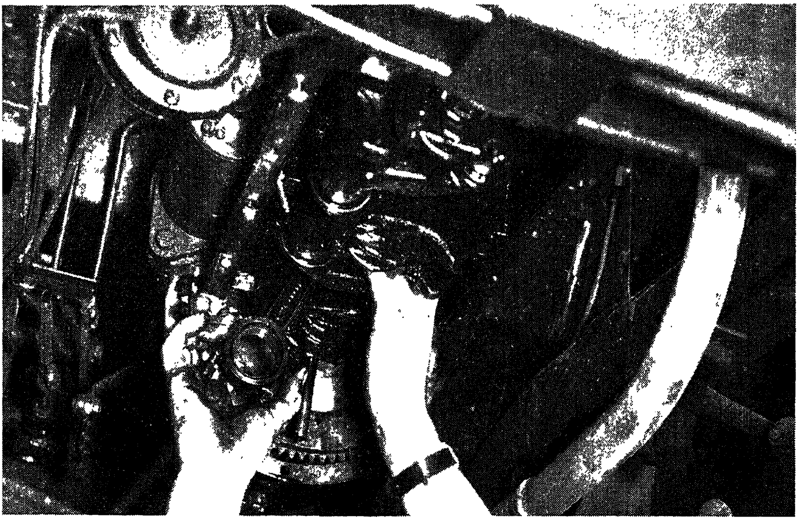


Fig. 16.—METHOD OF REMOVING PISTON AND CONNECTING-ROD ASSEMBLY WITH SUMP WITHDRAWN

plugs, and extract the lockwire from the dowel bolt attaching the distributor clamp plate to the cylinder head, and unscrew the bolt. This will enable the distributor assembly to be withdrawn from the engine. Do not disturb the pinch-bolt of the clamp plate or you will loose the ignition timing.

Slacken off the thirteen cylinder-head stud nuts a partial turn at a time in rotation until all are quite loose, then remove them entirely. This will enable you to remove the cylinder head and withdraw the cylinder-head gasket.

The upper end of the distributor-drive shaft will now be exposed, and it should be withdrawn from the distributor-drive tunnel and placed in a safe position.

Remove the series of $\frac{1}{4}$-in. hexagon nuts with extended bodies which attach the manifold to the cylinder block, and withdraw the manifold from the studs. Remove, also, the manifold gasket.

The tappet cover complete with fume pipe can now be removed, by releasing the clip retaining the fume pipe to the flywheel housing and unscrewing the two wingnuts attaching the valve-tappet cover in position. Do not forget on reassembly that the cover gasket must be refitted with the two oil drain-holes at the bottom.

The valves may now be removed, using a "C"- type compressing tool to compress their springs and extracting the cotters from their stems. This will release the spring caps and springs, which can be removed together with the valves themselves.

Note that the valves are numbered on their heads, No. 1 valve being located at the front end of the engine, and that they must always be reassembled in the same ports. Should new valves be fitted subsequently, it is wise to number them to ensure their correct replacement during future overhauls.

Note, also, that the springs have coils of progressive pitch and that the close-coiled end should be refitted upwards in contact with the cylinder-block casting.

Removing Distributor-drive Gear

The distributor-drive gear is held in position in the cylinder block by a hollow dowel in the upper end of the shaft tunnel. The hollow portion of the dowel is screwed with a 5-mm. thread into which a suitable screw may be inserted with which to withdraw the dowel. In obstinate cases it may be necessary to construct a small bridge-type extractor to effect withdrawal.

When the dowel is removed the distributor-drive gear can be withdrawn upwards through the drive tunnel.

The starter motor is released from the flywheel housing by removing its two attachment bolts and removing the water-inlet pipe casting from the cylinder block, taking care of the gasket between the joint.

Release the fan-drive pulley from the front of the engine by undoing the nut for the starting handle, and remove the dished washers found beneath it, noting that their dished sides face towards the fan pulley. The pulley can now be withdrawn with a suitable extractor.

Attention may now be given to the underside of the engine, which should be reversed in the stand.

Remove the engine sump by unscrewing its twelve attachment bolts, noting that the two bolts at the front end and the two at the rear end are provided with $\frac{3}{16}$-in. hexagon heads, while the remainder have $\frac{1}{4}$-in. hexagon heads, and that the two on each side of the oil pump are inserted from the upper side of the flange.

Timing Cover and Gears

Detach the timing cover by undoing the four fixing bolts from the front face of the cover and the two from the back face of the nearside engine bearer. Withdraw the dished oil-thrower washer from the crankshaft, observing that its flange faces towards the timing cover.

Bend back the edge of the lock-washer from the setscrew on the end of the camshaft, which retains the camshaft sprocket in position. Unscrew the setscrew and withdraw the lock-washer and plain retaining washer.

The timing chain and sprocket can now be withdrawn from the end of the crankshaft and camshaft together, using levers to ease each sprocket forward a little at a time alternately.

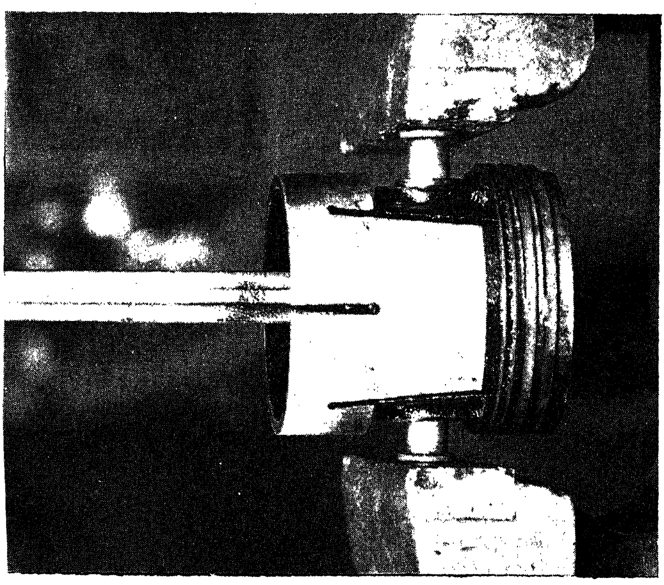


Fig. 17.—METHOD OF CLAMPING PISTON IN VICE

Showing the use of shouldered plugs inserted in the gudgeon-pin ends to take the pressure of the vice.

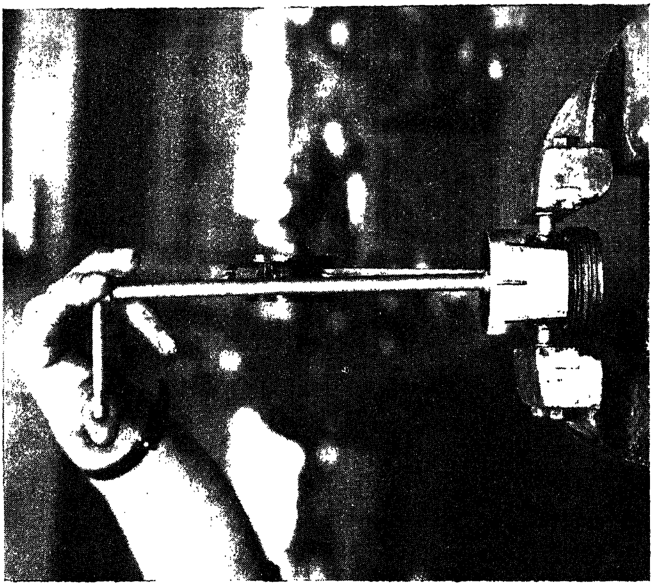


Fig. 18.—REASSEMBLING THE PISTON

A tommy bar 6 in. long provides ample pressure on the clamp screw.

The oil pump is attached to the cylinder-block casting by a flange and two setscrews. Removal of the setscrews releases the pump, which is then easily withdrawn from its drive tunnel.

If necessary, the camshaft may now be withdrawn from the cylinder block from the forward end, and the tappets may be withdrawn from their guides.

Piston Assemblies

The piston assemblies are removed by releasing the big-end caps from the connecting rods, withdrawing the connecting rod from the crankshaft bearing and replacing the cap in the same position. The connecting rods and caps are numbered to correspond with their respective cylinders, and should be retained in the same positions.

The piston and connecting-rod assemblies are now removed from the crankcase end, carefully rotating the crankshaft to provide maximum clearance during the operation and avoid damage to the pistons. A similar procedure must be adopted when replacing the piston and connecting-rod assemblies, and care must be taken to see that the gudgeon-pin clamp screws are on the opposite side of the engine from the camshaft.

When separating the piston from the connecting rod, do not hold the piston or the rod in the vice while undoing the clamp screw, use shouldered plugs inserted in both ends of the gudgeon pin to take the pressure of the vice, and avoid undue pressure.

When reassembling the pistons, do not apply too much pressure on the clamp screw—a tommy-bar 6 in. long provides ample pressure.

Flywheel

In order to be able to remove the flywheel, it is first necessary to remove the rear main bearing cap and bottom half-bearing. Having done this the two flywheel-locating dowels should be carefully tapped out towards the rear of the engine, special care being exercised not to cause damage to the oil-return threads and oil thrower on the crankshaft.

Extract the lock-wire from the flywheel fixing bolts and withdraw the bolts.

Using a copper or rawhide hammer, gently tap the flywheel rearwards, while slowly rotating the crankshaft to ensure its even removal from the attachment flange.

The crankshaft is removed by detaching the bearing caps from the centre and front main bearings.

When reassembling, it should be noted that both main and big-end bearing shells are prevented from rotating by a projecting lip which engages in a recess in the bearing housing, and that both these lips should be on the same side of the bearing when assembled, but at opposite ends, of course.

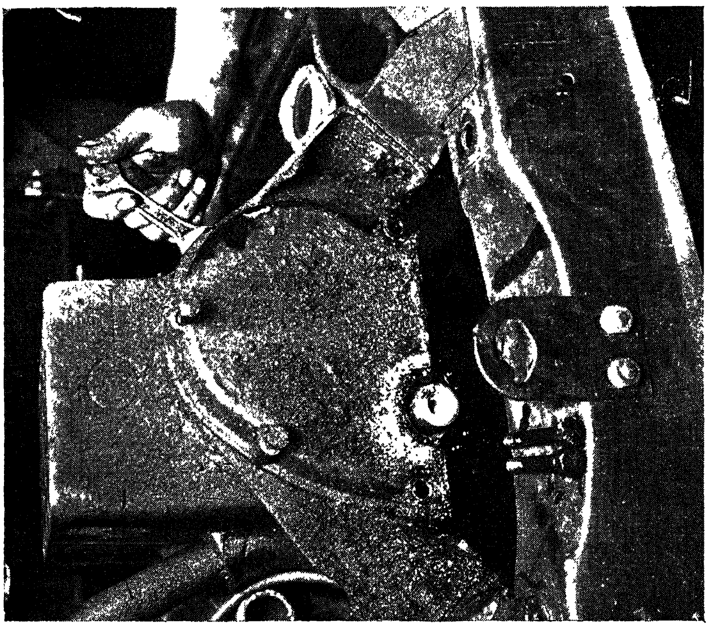


Fig. 19.—REMOVING TIMING COVER

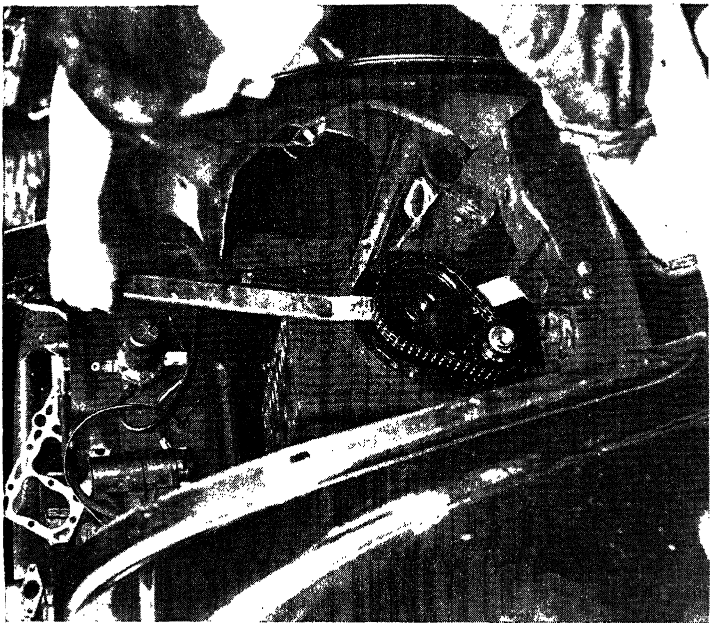


Fig. 20.—REMOVING TIMING CHAIN AND GEAR

Removal of Camshaft with Engine in Position in Frame

When necessary, the timing chain and camshaft can be removed from the engine without withdrawing the engine unit from the frame.

This is accomplished by raising the bonnet, draining the radiator, disconnecting the battery positive lead, releasing the hose connections, detaching the radiator shell, and removing the radiator in the manner already described for removal of the engine.

When these items have been dealt with, disconnect the low-tension wire from its terminal on the distributor, and release the fan-belt tension by slackening the dynamo adjusting nut. This will enable you to remove the belt from the fan pulley and release the bolts fastening the dynamo to its cradle. When the dynamo attachment bolts are withdrawn the dynamo may be removed and transferred to the tool box on the dash without disturbing the wiring.

The high-tension leads from the sparking plugs and the coil should now be detached, and the locking wire removed from the distributor clamp-plate retaining bolt. Removal of this retaining bolt will permit the removal of the distributor assembly complete with clamp-plate, which should not be disturbed, in order to retain the ignition setting.

Release the throttle control-cable bracket from the cylinder head by removing the retaining setscrew, and release the control wire from the throttle lever by slackening the clamp-nut.

Detach the air-intake silencer bracket from its attachment to the cylinder head, and release the clip attaching it to the air-intake pipe. This will enable you to remove the air silencer.

Jack up the nearside front wheel and place a solid stand beneath the axle. Remove the wheel and the inspection panel, in the nearside wing valance, which is located in position by three screws.

Detach the mixture-control wire from the carburettor-jet lever and remove the carburettor from the manifold by removing its two attachment nuts.

Release the exhaust pipe from the manifold by removing its two attachment bolts, carefully retrieving the copper-asbestos sealing gasket.

Remove the cylinder head by unscrewing its thirteen retaining nuts, and remove the engine oil sump.

Release the engine from its forward mounting by removing the two $\frac{5}{16}$-in. nuts equipped with plain and spring washers, and raise the front end of the engine with suitable lifting tackle until the fan pulley is clear of the chassis front cross-member.

Unscrew the starting-handle dog nut and remove the dished washers, remembering that the dished sides face towards the pulley on reassembly, and with a suitable extractor withdraw the pulley from the crankshaft end.

Removing Timing Chain and Gear

Release the timing-gear cover by undoing the series of four fixing bolts and the two setscrews from the rear of the nearside engine bearer.

Carefully remove the dished oil thrower from the crankshaft, noting that its flange faces towards the timing cover.

Carefully tap back the locking washer from the setscrew which attaches the sprocket to the camshaft, and unscrew the retaining screw, removing the lock washer and plain steel washer.

The timing chain, in position on the sprockets, can now be removed as an assembly by carefully levering each sprocket forward a little at a time with suitable small levers.

Raise the valves as far as possible and retain them in the open position by inserting small wooden wedges or a strip of wood under their heads.

Extract the dowel retaining the distributor-drive gear and shaft in position in the cylinder block. The dowel is provided with a 5-mm. tapped hole into which a bolt may be screwed for the purpose of extracting it from its housing. If it is a tight fit, a small bridge-type extractor can be made from steel bar to facilitate its removal.

When the dowel is removed the distributor drive gear is easily removed by easing it upwards and withdrawing it through the tunnel in the cylinder block.

The tappets should now be raised to their fullest extent, and held securely in this position by suitable wedges, while the camshaft is withdrawn from the forward end of the cylinder block.

With the camshaft removed, the tappets can be withdrawn downwards from their guides. Should new tappets be fitted, their fit should be such that the tappets just fall from their own weight in their guides when lubricated with engine oil.

Replacing Camshaft and Timing Engine

When replacing the camshaft, set it so that its keyway is at 7° before top-dead-centre position.

Set the crankshaft with its keyway at top dead centre.

Double the timing chain so that its two bright links come together and so that you have a long portion on one side of the link and a short portion on the other. With the long portion of the chain in your right hand, insert the crankshaft sprocket with the tooth marked "T" engaging the lower bright link.

Now insert the camshaft sprocket so that the tooth marked "T" engages the other bright link of the chain and to the right of the camshaft sprocket.

The assembly can now be replaced on the crankshaft and camshaft, noting that the bright link on the camshaft sprocket is at the top and that on the crankshaft sprocket is at the bottom.

When the sprockets are properly in engagement with their keyways and the chain, the timing should be as follows:

Inlet opens 8° before T.D.C.

Inlet closes 52° after B.D.C.

Exhaust opens 52° before T.D.C.

Exhaust closes 20° after B.D.C.

When the sprockets are properly refitted the retaining screw for the camshaft sprocket may be replaced, not forgetting to replace the two washers and bending the locking washer to retain it in position.

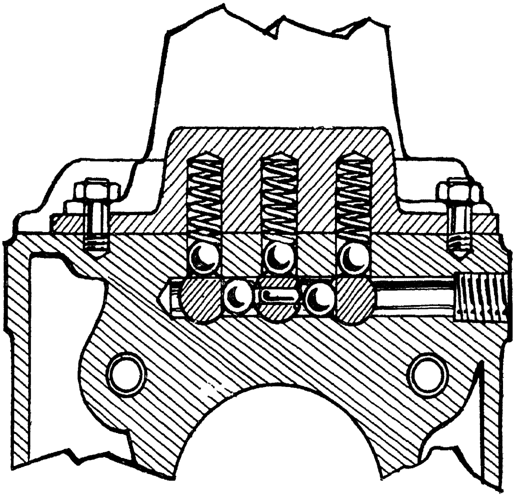


Fig. 21.—THIS CLEARLY SHOWS THE POSITION OF THE LOCATING BALLS AND THE TWO INTERLOCKING BALLS AND PLUNGER IN THE REAR WALL OF THE GEARBOX OF THE MORRIS EIGHT

Setting Ignition Timing

Now set the oil-pump shaft so that the slot in its upper end is exactly at right angles to the camshaft, and then inset the gear through the upper orifice in the cylinder block with its tongue set at eleven o'clock, i.e. 30° anti-clockwise in relation to the slot in the pump, noting that the tongue is offset and that its widest portion should be to the rear of the engine.

The dowel hole in the bush should be carefully lined up with the dowel hole in the cylinder block.

As the gear meshes with the camshaft gear it will rotate into engagement with the pump shaft, and the distributor-driving tongue at its top end will take up a position at one o'clock.

When the distributor and drive shaft are temporarily offered up it should be found that the rotor is pointing between the seven o'clock and eight o'clock positions, with the engine correctly set for firing on No. 4 cylinder.

The distributor is set with its points just breaking with the piston at top dead centre.

When the timing is correctly set the sump may be replaced, together with the timing cover and crankshaft sprocket, the engine being now lowered into position on to its bearers.

This enables replacement of the head to take place, together with that of the other components, which are reassembled in the opposite order to their removal.

To Dismantle the Gearbox of the Morris Eight (Series " E ")

The gearbox should be removed from the car in the manner already described, and held in a vice by means of a short length of bar threaded

at its upper end to engage with the drain-plug hole. The thread of the plug hole is 30 mm. diameter, 2 mm. pitch. Care should be taken not to lose the three locking balls and springs in the rear wall of the box.

With the gearbox firmly secured, remove the circlip on the nearside of the clutch-operating fork shaft and the adjusting screw and locknut from the clutch-operating lever.

Now release the clutch-operating lever return spring, and remove the clutch thrust-pad by extracting the two retaining springs.

Withdraw the taper pin locating the clutch fork, driving this upwards by passing a suitable pin-punch through the clutch-housing drainage hole. This will enable you to tap out the clutch-operating fork shaft towards the offside with a suitable drift.

Detach the cover plate from the forward face of the gearbox by removing the three retaining bolts, noting that the two upper ones are provided with spring washers and the lower with a plain copper washer.

Withdraw the split-pin from the nut at the rear end of the box which attaches the flange to the mainshaft, unscrew the nut, and withdraw the washer. With a suitable extractor withdraw the flange from the mainshaft. Withdraw the speedometer-drive housing after removing the four retaining nuts, and note that the joint is made with a paper gasket.

At the rear of the speedometer-drive housing will be found a felt oil-retaining washer; this should be renewed on reassembly, and it is important to see that the outer edge of the washer goes right home in the recess provided for it.

Note, also, that a pen steel washer is fitted in the register for the gearbox-mainshaft bearing at the forward end of the speedometer-drive housing.

Remove the bearing guard, taking note that the dished portion lies towards the bearing, and with a suitable extractor withdraw the bearing from the rear end of the mainshaft together with the distance-piece, speedometer-drive gear, and shim.

Now extract the locking wire from the six square-headed screws, locating the shifting forks and stops to the selector shafts, and remove the screws.

The selector shafts can now be withdrawn one at a time, taking great care not to lose the locking balls located in the rear wall of the box.

This will permit the gear shifters to be withdrawn, and care should be taken to note their correct positions for reference on reassembly.

The layshaft spindle should now be removed by releasing the dowel bolt from the underside of the gearbox casing at the rear, and tapping the layshaft spindle rearwards with a suitable copper or brass drift. This will allow the layshaft gear cluster to drop into the base of the gearbox casing. With the copper or brass drift carefully tap the rear end of the mainshaft forward, which will at the same time force the drive-gear assembly from its housing.

The mainshaft ball bearing in the rear wall of the box can now be gently tapped out of its housing in a rearward direction, using a copper drift to avoid damage, withdrawing the bearing from the shaft.

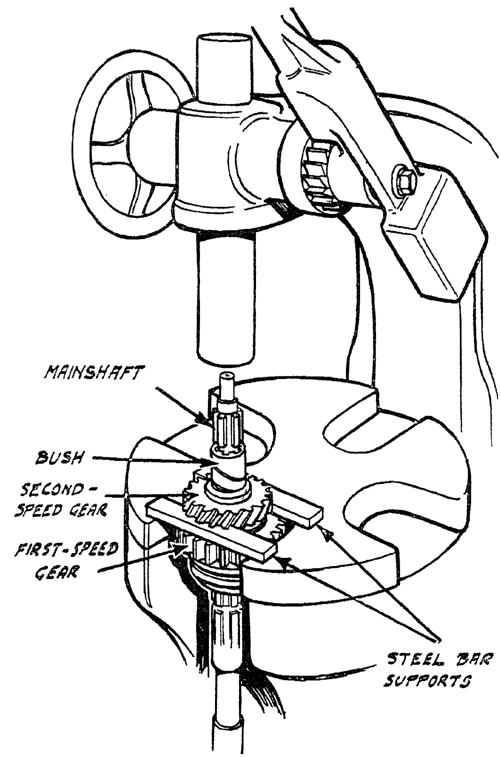


Fig. 22.—THE METHOD ADVISED FOR WITHDRAWING THE MAINSHAFT FROM THE SECOND GEAR BUSH, UTILISING A PRESS

Withdrawing the Mainshaft Assembly

The mainshaft assembly complete with gears may now be withdrawn in a forward and upward direction through the upper portion of the box.

This enables the layshaft gear and its two thrust-washers—one either end—to be lifted out of the bottom of the box.

The reverse gear may now be removed if necessary by extracting the split-pin from the bolt and nut which retain the reverse-gear shifter to the side of the box, removing the bolt and extracting the shifter. The reverse-gear spindle is removed by withdrawing the dowel bolt from the nearside of the gearbox and gently tapping out the spindle from the forward end with a suitable copper drift.

Dismantling the Mainshaft Assembly

The gearbox mainshaft assembly is dismantled by withdrawing the top- and third-gear synchromesh hub from the forward end of the shaft, observing, for the purpose of reassembly, that the plain side of the hub faces towards the rear of the gearbox.

The third-gear collar should now be released by pressing down the spring-loaded locating plunger and rotating the collar so that its splines register with the splines on the shaft, enabling the third-speed gear to be

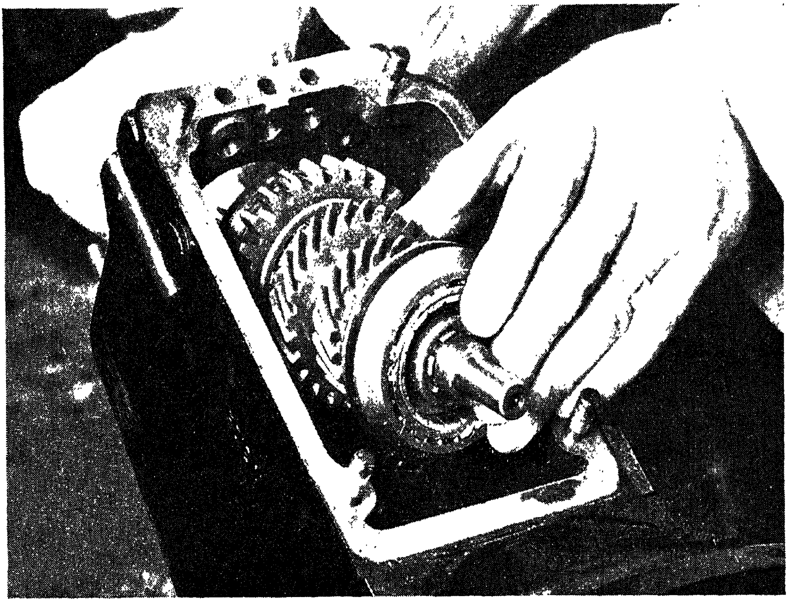


Fig. 23.—SHOWING HOW THE MAINSHAFT ASSEMBLY IS WITHDRAWN FROM THE GEARBOX IN AN UPWARD AND FORWARD DIRECTION

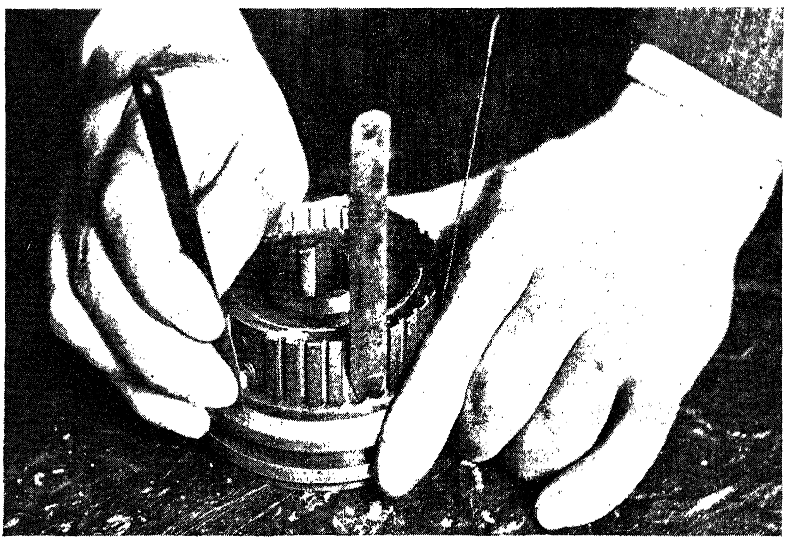


Fig. 24.—THE RECOMMENDED METHOD OF REPLACING THE LOCATING SPRINGS AND BALLS OF THE SYNCHRO-HUB

withdrawn from its bush. Care should be taken during this operation not to lose the plunger and spring.

Now remove the circlip which is found at the rear of the second-gear synchromesh hub, easing the hub back as far as it will go. The mainshaft should then be placed in a press, with the second-speed gear supported on each side by suitable steel packing strips, while downward pressure is applied to the shaft in order to extract the bush and the gear from the forward end of the shaft (*see* Fig. 22).

To remove the second-speed synchromesh hub unit, extract the second-speed gear collar by pressing down its spring-loaded locating plunger, rotating the collar until its splines coincide with the splines on the shaft to enable the hub to be withdrawn.

Should it be necessary to separate the striking dog from the synchromesh hub and cone assembly, remember first to cover the assembly with a duster in order not to lose the six locating balls and their springs.

Replacement of these balls and springs is best achieved by the use of old hacksaw blades, tapered at their ends and inserted between the hub and the striking dog to hold the balls in their housings with their springs depressed while the striking dog is pushed into position.

Reassembling the Box

When reassembling the box the reverse gear and its shifter should be first replaced, of course, followed by the layshaft gear cluster, taking care to see that the thrust-washers are placed in position at each end. The layshaft gear cluster should remain in the bottom of the box until the mainshaft assembly has been replaced.

The mainshaft assembly should now be inserted in the box through the top opening, followed by the drive gear, complete with bearing through the forward bearing housing. The front-bearing cover plate may now be replaced.

With a suitable tapered mandrel bring the layshaft into register with its spindle housings, and then push the spindle into position from the rear end of the gearbox, taking care to see that the dowel-bolt hole is in register with the bolt hole in the gearbox casing.

The remainder of the assembly is quite straightforward, and takes place in the reverse order to that of dismantling, but do not forget to replace the selector shaft interlocking and locking balls correctly, and do not lose the interlocking ball plunger which passes through the centre selector bar.

THE TRIUMPH CLUTCH AND GEARBOX

By H. W. ALLISON

WITH the exception of the 9·57-h.p. and 12·95-h.p. models, all Triumph cars are fitted with Borg & Beck clutches, which are dealt with elsewhere.

CLUTCH ON EARLY GLORIA MODELS

The Triumph clutch of the early Gloria models is a single dry-plate type, operated by a pedal-controlled fork which acts on the flange of the thrust-bearing housing. The bearing is held in the housing by means of a plate and a spring ring.

Refacing Friction Plate

The friction plate is a built-up type, the plate to which the moulded asbestos facings are riveted being attached, also by rivets, to a flexible coupling, which is in turn riveted, to the metal centre section. The facings are segmented, after fitting, there being in all eight pieces, each pair attached by four rivets, and the plate is slightly dished, to ensure a smooth engagement between the face of the flywheel and the trailing end of each segment. It should be noted when assembling the clutch that the side of the plate, to which the flexible coupling is attached, faces the flywheel. It is a good plan, when refacing a plate, to fit each succeeding rivet to the opposite side of the plate, so that the rivets present an appearance of head, tail, head, tail, and so on when looking at one side of the plate.

Removing Gearbox Clutch

To obtain access to the clutch, the gearbox must be removed, and the following is the recommended method of procedure.

Disconnect the front end of the propeller shaft and the speedometer and free-wheel control cables. Slacken the engine side bearer bolts (if fitted), remove the top half of the gearbox rear support, and raise the engine by means of a jack placed under the flywheel housing. Remove all bolts from the bell housing, not forgetting the two starter-motor bolts. Disconnect the clutch withdrawal shaft lever return spring. Loosen the gearbox by levering the rear end, after which a good pull will free it from the engine. Pull out the toggle operating sleeve and with it the withdrawal bearing and housing complete, remove the six split-pinned nuts holding the pressure-plate springs, and carefully prise the pressure plate

from the flywheel. Note that there is sometimes a tendency for the guide studs to stick in the flywheel, and these should be eased with paraffin. Remove the driving plate, and the dismantling is completed.

If it is desired to renew the flywheel spigot bearing, this will present no difficulty where a recent model is concerned, as the end of the crankshaft is recessed, and a hook placed behind the bearing is the only tool required when the lock plate has been removed, or the lock-plate tabs bent outward. Earlier models have no such recess, and the alternative to breaking up the bearing and removing it piecemeal is to take off the flywheel and with it the bearing, after which it can be knocked out without difficulty.

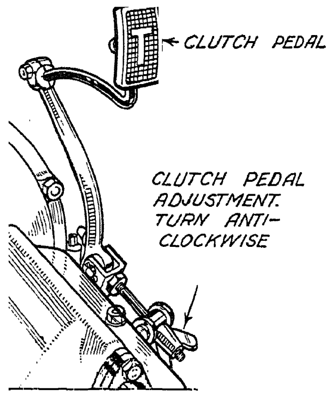


Fig. 1.—CLUTCH PEDAL ADJUSTMENT

Reassembly

When reassembling, a centralising tool (an old primary shaft will serve the purpose) should be used to ensure that the driving plate is correctly lined up. The pressure plate, springs, and slotted nuts are now refitted, taking care that the tag ends of the split-pins point towards the centre of the clutch.

Adjust the three toggle arms by means of the screws and locknuts provided, to give not less than ⅛-in. movement before the levers come into contact with the ends of the slots in the sleeve of the pressure plate, insert the toggle sleeve, and while exerting slight pressure on it, equalise the adjustment of all three toggles. There must be idle movement in these arms irrespective of the play in the pedal, otherwise the clutch will slip. Also the amount of movement must be equalised, or the clutch will be fierce in action.

Smear the gearbox primary-shaft splines with grease, preparatory to refitting the gearbox.

Place the gearbox in line with the clutch, but supported well back on the frame member. Slide it forward till it can be seen through the clutch inspection hole that the primary shaft is entering the clutch centre, and when it is judged that the splines of the shaft and driving plate are on the point of engaging, pull the gear lever into the fourth speed (top gear), and as the box is pushed farther forward rotate the primary shaft from the rear end of the box ; this will simplify engagement of the splines. Push the clutch housing close up to the flywheel housing.

Insert the two top housing bolts and lightly draw them up, following

with the two bottom bolts. Tighten both pairs equally and fit the remainder, including the starter bolts.

Connect the speedometer drive, lower the engine, refit the gearbox support clamp and tighten up the engine bearer bolts. Adjust the clutch pedal to give approximately $\frac{3}{8}$-in. idle movement before the withdrawal action comes into operation, and complete the reassembly.

Clutch Slip

Clutch slip may be caused by the presence of oil on the facings, wear of the facings, lack of idle movement in the operating pedal, or lack of play between the toggles and the ends of the slots in the sleeve portion of the pressure plate, and if allowed to develop may result in the faces of the pressure plate and/or flywheel becoming scored, in which case the parts must be refaced and washers fitted behind the clutch springs. If an appreciable amount of metal has to be removed, the fitting of a Don Flex-type of driving plate (obtainable from the makers) is recommended, as the linings are thicker.

Scraping Noise

The pieces of hide riveted to the clutch-withdrawal fork wear out in time, resulting in a scraping noise occurring when the pedal is depressed. The actual fitting of new hides is a simple matter, but necessitates removal of the gearbox.

The thrust and spigot bearings are grease packed during initial assembly, and as a rule do not require any attention. It is advisable to repack them, however, if the clutch is taken down for any purpose.

GLORIA GEARBOXES

All Gloria-type gearboxes have four speeds, with double-helical third speed and constant-mesh gears.

Dismantling

To dismantle the gearbox after it has been removed, take out the bolts and nuts holding the clutch housing to the gearbox, noting that it is not necessary to interfere with the clutch withdrawal assembly. Remove the nuts and washers securing the free-wheel case, and take away the free-wheel assembly complete.

Remove the split-pin, nuts, and spring on the reverse-gear selector free-wheel interconnecting rod, also the two bolts securing the free-wheel control fork to the gearbox, and take away the free-wheel adapter case. Take off the gear control complete and remove the three bolts securing the gate assembly to the box, after which this also may be lifted off.

Take off the reverse-gear shaft and the layshaft lock plates and tap out the layshaft, which will allow the layshaft gear to fall into the bottom of the box.

Next drive out the selector shafts and release the forks, taking care that the selector balls or plungers and springs are not lost.

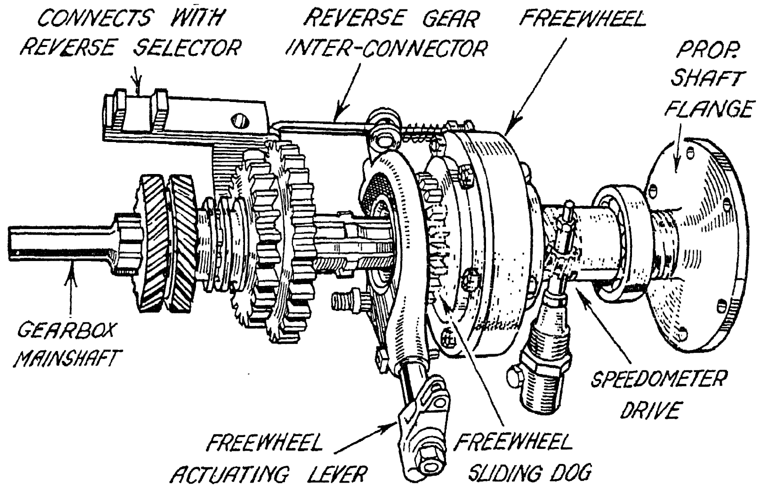


Fig. 2.—THE INTERIOR MECHANISM OF THE FREE WHEEL—APPLICABLE TO ALL GLORIA MODELS

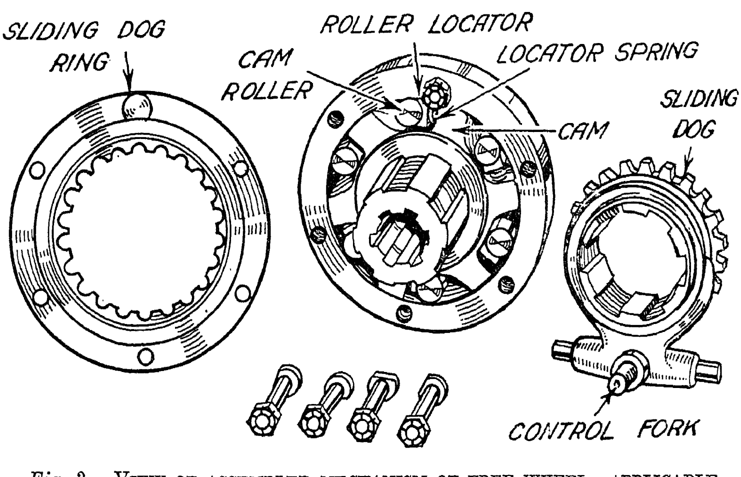


Fig. 3.—VIEW OF ASSEMBLED MECHANISM OF FREE WHEEL—APPLICABLE TO ALL GLORIA MODELS

The primary and main shafts can now be removed, the reverse shaft withdrawn, and all the gears taken out.

To remove and dismantle Free-wheel Assembly

The free wheel fitted to all Gloria-type gearboxes is simple in design, repair or even adjustment rarely being necessary. To dispose of a fairly common fallacy, it may be pointed out that the free wheel cannot slip, and in any case of slip between engine and transmission, the clutch must be examined.

To remove and dismantle the free-wheel assembly, disconnect the front end of the propeller shaft and the speedometer cable, take off the gearbox rear-support clamp-plate, and jack up the rear of the engine, slightly higher than its normal position. Remove the coupling flange, after taking off the split-pin, nut, and washer. Take off the six casing attachment-bolt nuts, and pull off the casing, with which will come away the free-wheel clutch drum, etc. A few taps on the end of the drum shaft will separate the drum and casing.

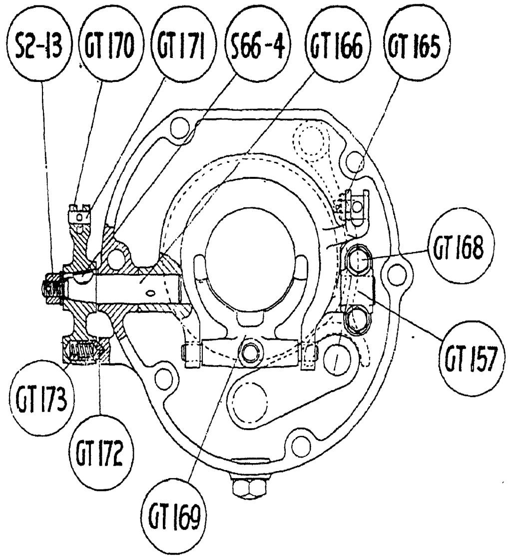
To remove the adapter casing and the remainder of the free-wheel mechanism, disconnect the operating rod or cable, as the case may be, from the operating lever on the side of the casing, take off the reverse-gear interconnecting rod nuts and spring (these will be seen to the offside and slightly below the centre of the adapter casing), and remove the two $\frac{5}{16}$-in. bolts holding the control-fork bearing. The adapter casing, etc., can now be pulled off.

To dismantle the drum, remove the six split-pinned nuts and bolts, and take off the sliding dog ring. Lift out the rollers, locators, and springs, and remove the cam. The mainshaft adapter bearing is a press-fit on its stub. This part of the dismantling completed, reverse the drum, slide off the speedometer pinion sleeve, take out the pinion grub-screw, and remove the pinion distance-piece and bearing. This bearing is a press-fit on the shaft. The parts left in the casing consist of the speedometer wheel and sleeve, both of which come away when the sleeve is unscrewed. By compressing the ends of the distance-piece circlip with a pair of pliers, the circlip may be pulled out, after which the distance sleeve, rear bearing, and oil thrower can be knocked out.

Turning now to the adapter casing and its contents, the control sliding fork, and with it the sliding dog, will fall out when the casing is taken off the studs, and if it is desired to remove the control fork, this can be done after driving out the taper pin through the hole provided in the casing, and pulling out the fork spindle with the operating lever attached.

Reassembling

Reassembling is straightforward, though there are one or two points to watch. One of these is that the end-casing oil thrower should be refitted with the lip facing rearwards.



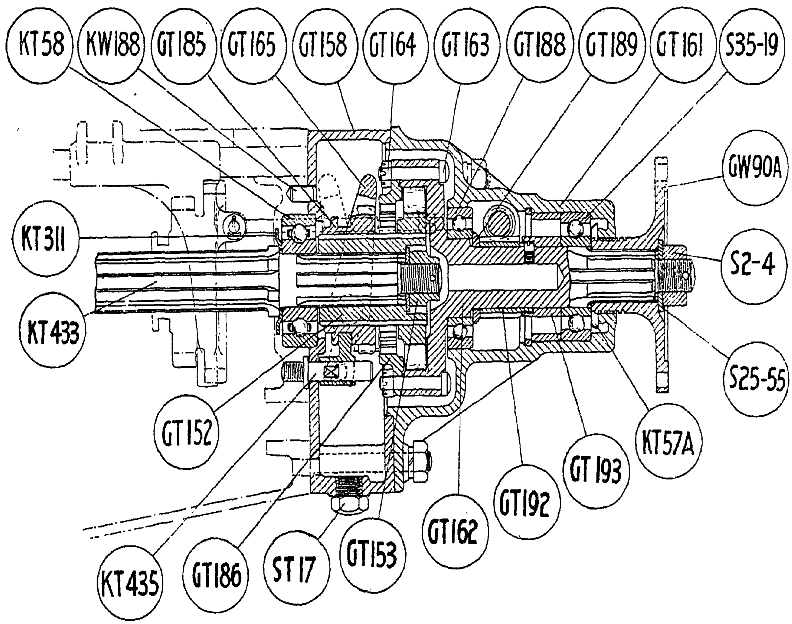


Fig. 4.—THE FREE WHEEL ASSEMBLY—APPLICABLE TO ALL GLORIA MODELS

Secondly, and this is important, the sliding fork must be refitted with the boss facing inwards, otherwise it will not be possible to lock the free wheel, owing to the fact that this boss will prevent complete engagement of the sliding dog and dog-ring teeth.

Lastly, it should be noted that the roller locators are radiused at one end, and the radiused end must contact with the cam. If these locators are fitted the wrong way round they are liable to jam and burst the drum. The best way to reassemble this portion of the mechanism is to put all the springs in position in the holes in the cam, and drop the latter in place, then fit the locators on the springs in the manner already described, and lastly, drop the rollers in position while holding the locators back on their springs, with the aid of a screwdriver, or something similar: the last roller may be a tight fit, but it will drop in easily enough if the cam is moved round slightly.

If the sliding-fork pin is taken out for any reason, make sure this is refitted securely, otherwise it will prevent full movement of the fork.

SPECIAL NOTES

The main-shaft gears cannot be refitted until the primary shaft is in position.

Care should be taken not to refit the free-wheel sliding dog fork the wrong way round, or the boss of the fork will prevent complete locking of the free wheel.

The reverse-gear selector–free-wheel interconnection-rod spring must be given a very light tension when reassembling.

If the engine is not fitted with side bearers, the rear end must be supported by a jack or blocks before an attempt is made to remove the gearbox.

Jumping out of Gear

Trouble with jumping out of gear is usually an indication of the necessity for examination and possible renewal of the selector plungers (or balls) and springs. Should this procedure fail to effect a cure in the case of the fourth speed, however, it should be noted that a few cases have been experienced of the bush of the third-speed sliding gear working out of position, usually due to a seizure, which renders it impossible for the fourth-speed gear to enter fully into mesh, with the result that the transmission load is sufficient to pull it out again. A new bush should be fitted in such cases, and as the final machining operation is carried out after fitting the bush to the gear, it is better to obtain another gear from the makers.

Failure to complete the engagement of reverse gear is almost invariably an indication of an incorrectly tensioned free-wheel connecting-rod spring, and this is a matter which can be rectified without taking the gearbox to pieces. It is necessary only to disconnect the front end of the propeller

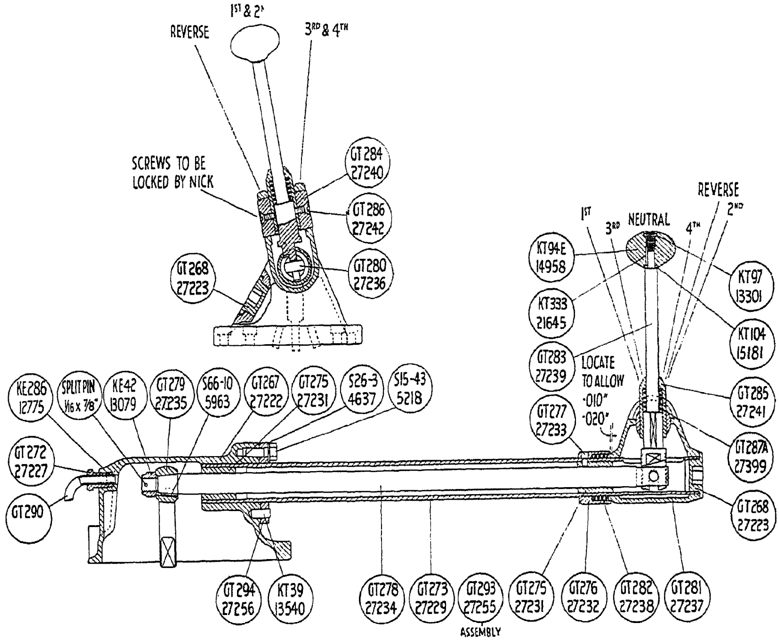


Fig. 5.—GLORIA TYPE GEAR CONTROL ASSEMBLY (1934 AND 1935)

shaft, and remove the free-wheel case as already described. The necessary adjustment is carried out on the foremost of the two nuts mentioned earlier.

Grating Noise in Free Wheel

A grating noise when in free wheel indicates the necessity for adjustment of the control cable, which is inclined to stretch when new. To cure this, the locknut on the cable stop at the side of the gearbox must be slackened off and the adjusting nut screwed away from the stop. When correct adjustment has been obtained, the locknut must be tightened up again.

(This note is not applicable to 1936 and later Gloria models, as the free wheel fitted to these models is lever operated.)

Some models are equipped with a gear-control lever operated reversing light, and in these cases, jumping out of reverse gear may be due to the light switch bottoming. The remedy is to fit one or two additional washers under the switch body, which enables the gear to enter fully into mesh.

Dismantling Synchromesh Gearboxes

The synchromesh gearboxes fitted to more recent productions are not prone to any particular troubles, therefore it is not proposed to do much

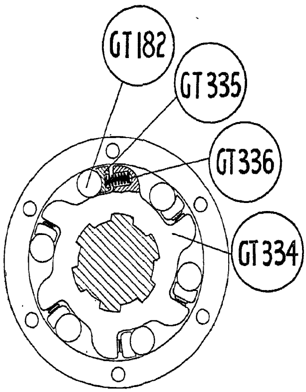


Fig. 6.—FREE-WHEEL CLUTCH DRUM, CAM, ROLLERS, SPRINGS, AND LOCATORS

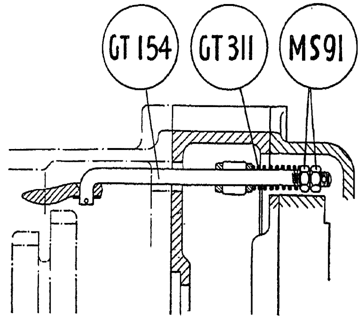


Fig. 7.—FREE-WHEEL REVERSE GEAR INTER-CONNECTION ROD

more than give instructions for dismantling and reassembling, as follows. (Removal and refitting instructions are practically identical with those already given for earlier models.)

Remove the rear coupling flange, take off the rear cover, and remove the layshaft and reverse-shaft retaining plates.

Tap out the three selector rods and the layshaft from the clutch-housing end of the gearbox.

Remove the clutch-withdrawal lever from the shaft and the four bolts securing the front cover.

The first-motion shaft and the front cover can now be removed by lightly tapping the mainshaft from the rear end of the box, after which the mainshaft is punched out from the front end.

Unless the gearbox case is to be changed, the clutch withdrawal fork and reverse wheel and shaft need not be interfered with.

To reassemble the box the above procedure must be reversed, note being taken that the layshaft should be driven in last of all.

Care must be taken to ensure that the helical gears on the mainshaft are correctly meshed with the corresponding gears of the lay-gear assembly.

The oil way in the layshaft must be in line with the oil hole in the gear-box case.

If Jumping out of First Gear is Experienced

Difficulty with jumping out of first gear may be experienced with some of the early synchromesh gearboxes, and it is usually possible to

cure this tendency by deepening the first-gear slot in the first- and second-gear selector rod, fitting a slightly stronger spring with a small plug behind it to compensate for the slot modification.

The gearbox need not be dismantled or even removed for this modification, and it is necessary only to detach the front end of the propeller shaft from the gearbox coupling flange, and take off the flange and rear cover as already described. The removal and refitting of the selector rod and the fitting of the new spring and plug in the selector fork can be done without taking the fork away from the box.

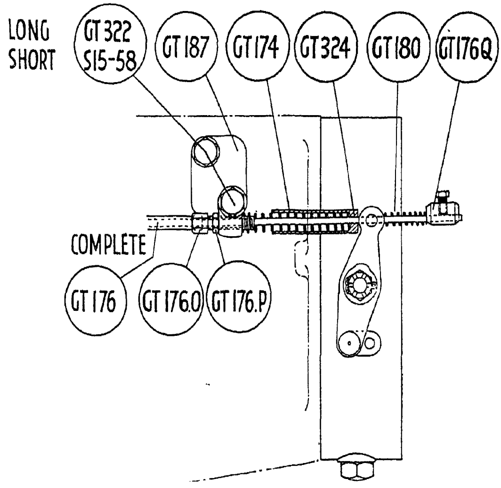


Fig. 8.—THE METHOD OF ADJUSTING FREE-WHEEL CABLE, 1934 AND 1935 GLORIAS

Oil Leak

An oil leak from the front end of the synchromesh-type gearbox will probably be due to wear of the oil-return thread. The cure is to renew the front cover, which is an inexpensive item. When the gearbox has been removed, it is only necessary to take out the four bolts holding this cover—the gears need not be interfered with at all. If the faces of the cover and box are kept perfectly clean, a new joint will ensure a leak-proof job and a jointing compound need not be used.

Rattle in Control Gear

A remote type of gear control, in slightly different forms, is fitted to all models.

The only troubles likely to occur are rattles and oil leaks, the latter in the vicinity of the pivot bracket. Dealing first with rattle, this usually develops in the joint of the shaft and lever, and it can often be cured by taking out the plug in the side of the pivot bracket, bending back the tab of the lock washer then exposed, and tightening the joint pin. If it is not possible to do this, it may be assumed that the shoulder of the pin is already butting, and in this case the necessary contraction of the split end of the control shaft may be obtained by fitting a thin washer under the head of the pin. It is usually better to take the control off in order to do this, as removal of the pin allows the spring-loaded control lever to jump

out of position, and it is difficult to get it back with the control *in situ*. It is important to remember to refit the tab washer.

Rattle may develop owing to wear of the phosphor-bronze control-lever ball cup. If the latter is the split type fitted to recent productions, tinning will ensure a tighter fit in the pivot bracket, with consequent better grip on the lever ball. The lever, and with it the two halves of the cup, are released in the manner described above. Care should be taken not to omit the loading spring when reassembling.

An anti-rattle device fitted to some of the earlier types of control consists of a spring-loaded half-moon-shape section, which fits in a slot cut in the ball of the control lever. In some cases, two sections are fitted, one on either side of the ball. The cure for wear is to tin or renew these pieces. As they are prone to fly out when the control lever is pulled away from the pivot bracket, care in dismantling is necessary.

The control shaft operates in a bushed tube, and the best method of curing an oil leak from the rear end of the control is to remove the front bush, cut it in two, and refit it, interposing a felt washer between the two halves.

To dismantle the control completely it is necessary to take out the plug at the side of the pivot bracket, and remove the lever assembly, in the manner already described. Then the end plug may be withdrawn, which will release the pivot bracket from the shaft tube. The latter is attached to the control tower by means of three bolts, and after these have been taken out the dismantling can be completed.

THE VAUXHALL FOURTEEN MODEL "J"

By G. T. CLARKE, F.I.M.T.

IN some detail the engine and other working parts are as the Ten and Twelve, therefore, when that is so, the fact will be mentioned so that the reader can refer to that section of this work and thus save repetition.

Figs. 1 and 2 show a longitudinal section and transverse section respectively.

Engine

Bore diameter: 61·5 mm. (2·42 in.).
Stroke: 100 mm. (3·94 in.).
Compression ratio: 6·75 to 1.
Firing order: 1, 5, 3, 6, 2, 4.
R.A.C. rating: 14·07 h.p.

Oil Pump, etc.

The oil-pressure warning device is on the same lines as the Ten and Twelve, as also the oil pump, which should show a pressure of 30 lb. per square inch with the car running at 30 m.p.h. To test, a calibrated gauge is inserted in place of the electrical oil-pressure warning device.

The pump housing is tubular and is a sliding fit in the bore of the distributor and oil-pump boss in the side of the crankcase. A grub-screw passes through the crankcase and into a chamfered hole in the side of the pump housing, which is thus held in position. The pump is shown on p. 242, Vol. II. The sump must be removed to get at the pump, and then by releasing the retaining-screw locknut and turning back the screw sufficiently to release the pump. Withdraw the pump after disconnecting the delivery pipe from the pump body.

Dismantling Oil Pump

Place the driving dog of the pump spindle in a vice fitted with brass clamps and remove the nuts from the cover and body bolts. When the cover and body have been removed the driven impeller can be lifted off its spindle, whilst the driving impeller and spindle can be drawn from the housing after the driving dog with its Woodruff key has been removed

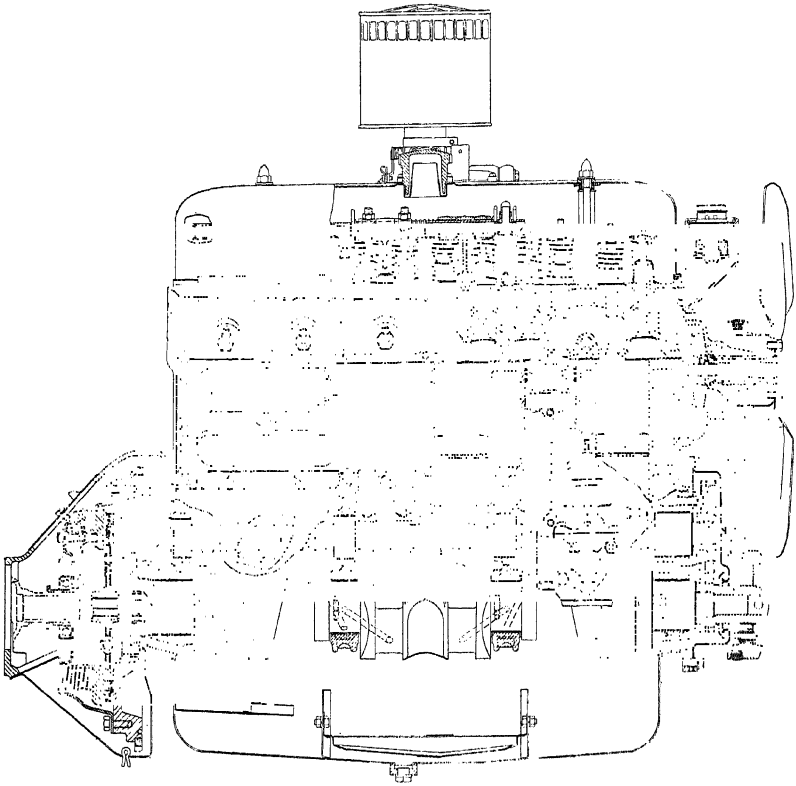


Fig. 1.—LONGITUDINAL SECTION OF ENGINE

from the opposite end of the spindle. Use a brass drift. Check for wear on the inner faces of the cover and spindle carrier. Dismantle the pressure relief valve and see that the plunger slides freely. All copper pipes harden with age, therefore it may be wise to anneal and clean thoroughly before refitting.

Before replacing the assembled pump be certain the spindle revolves with ease, and the dog on the end of the spindle engages correctly with the corresponding portion of the lower end of the distributor spindle. When inserting the grub-screw into the crankcase it should be noted that the tip of the screw should enter the hole in the top of the pump body and not the groove immediately above. The grub-screw should not be overtightened, otherwise the pump body is likely to be distorted and lead to seizure of the spindle. It is advisable to tighten with a screwdriver held with the tips of the fingers only, after which the locknut can be thoroughly tightened.

Oil Filter

It is recommended to remove the filter every 8,000 to 10,000 miles and renew. Should there be doubt about the flow through the filter, it can be tested by removing the outlet pipe (offset from the centre) when the engine is hot and running at a speed equivalent to 20 m.p.h. Oil should then flow if the filter is satisfactory. An intermittent flow denotes either a faulty filter or chokage. It is as well to try new filters in a similar manner when fitting. If it is found that oil is not circulating at all, the inlet pipe should be cleared.

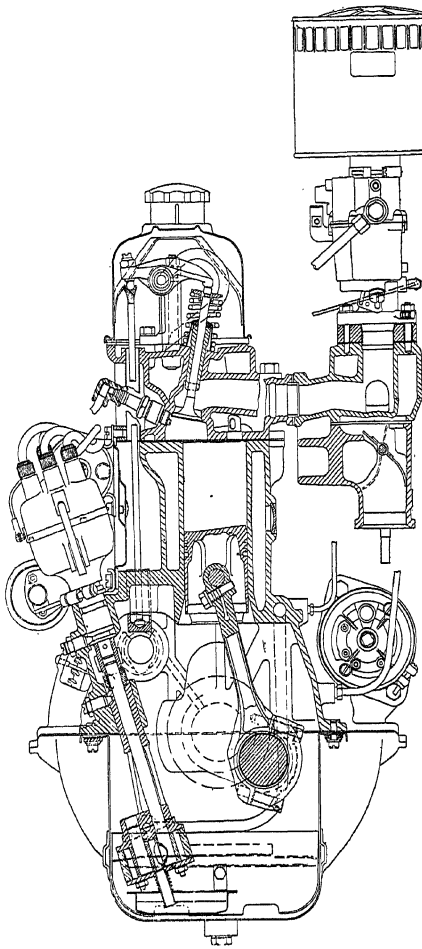


Fig. 2.—TRANSVERSE SECTION OF ENGINE

Cylinder Head

To remove the cylinder head, first drain the water from the block and radiator, then remove the bonnet. Remove the positive cable from the battery and the radiator hose from the lower end. Remove the plugs and rocker cover, then the rocker gear, crankcase ventilator pipe, ignition coil, and push-rod cover. Unscrew the petrol pipe from the carburettor and distributor suction pipe. The inlet and exhaust manifold can be removed as an assembly, after which the cylinder-head studs should be released in the reverse order to that shown in Fig. 3.

All core plugs should be examined, and any which show signs of leaking should be replaced. The operator is advised to use grease on the new cylinder-head washer to assist in bedding down. Do not wrap the clip at the rear of the cylinder around the suction pipe until the bolt has been tightened down, otherwise the clip may turn and bend the pipe. Do not

15	11	7	3	2	6	10	13
				FRONT			
12	8	5	1	4	9	14	

Fig. 3.—ORDER OF TIGHTENING CYLINDER-HEAD BOLTS

forget the induction-manifold collars when refitting the manifolds to the head.

Set plug points to ·040 in., the inlet valve clearance to ·008 in., and the exhaust valve to ·015 in., after the engine has been thoroughly warmed up.

Valves	*Inlet*	*Exhaust*
Opens	43° before T.D.C.	67° 48′ before B.D.C.
Closes	53° after B.D.C.	28° 48′ after T.D.C.
Included seat angle	60°	90°
Overall length	5·773 in.	4·65 in.
Stem diameter	·311 in.	·311 in.
Valve material	Silicon Chrome H3	Silicon Chrome H18

The method of adjusting the valves is shown on p. 243, Vol. II. The difference is in the tappet clearances, which should be strictly observed. The valve guides are only a light-drive fit in the cylinder head, therefore easily removed with a suitable drift. The pilot portion of the drift should be 1 in. long and $\frac{1}{4}$ in. diameter, with a shank $\frac{1}{2}$ in. diameter. If in doubt, renew the oil seals and be careful to check the fit of the guides before replacement. Also check fit of valve in guide itself. It will be noted the exhaust guides are counterbored $\frac{1}{4}$ in. Insert guide and drive in until the top face is $\frac{13}{16}$ in. above the milled face of the cylinder head.

To remove the valve springs, first remove the push-rods of the valves concerned. The push-rods can be withdrawn after removing the clearance adjusting screw and pushing the rocker sideways against its spring. The valve-spring collars are then removed with Britool No. 838. Whilst the collars are being removed, the valve itself must be supported with a length of $\frac{1}{4}$-in. steel rod inserted through the sparking-plug hole, and inclined so that the end of the rod presses on the centre of the valve head.

Valve-rocker Gear

To remove the valve-rocker gear, first remove the oil-feed and oil-overflow pipes from their connectors. Remove the setscrews and nuts attaching the rocker shafts to the cylinder head. Press the rear connector as far as possible towards the front and left of the rear section of the rocker gear—this will permit the front and rear sections to follow. Remove retaining clips and draw the parts off the shaft. The slackness between rockers and shaft should not exceed ·0025 in. If the shaft is worn (always on the underside), it must be renewed. The end float of the shaft is controlled by springs. The hardened rocker tips can be renovated by stoning. It will be noticed that the front and rear shafts are closed at the ends, therefore they must be reassembled so that the plug is at the outer

end of each shaft. When tightening down the rocker-shaft brackets, ensure that the upper end of the push-rods are located correctly, then tighten down evenly to prevent distortion. The removal of the push-rods presents no difficulty even when the rocker gear is undisturbed. Slacken the ball-end adjusting screws until the balls are clear of the cups in the push-rod, remove the hair-pin clips in the case of the exhaust rockers and, with the aid of a screwdriver, slide the rocker arms sideways and lift clear the push-rods. Scored cups or balls are likely to set up mysterious noises somewhat difficult to locate, hence the warning.

Push-rod Cover

To remove the push-rod cover, first remove the sparking-plug leads, then the crankcase-ventilator pipe, but leaving the pipe elbow in position on the cover. Remove the setscrews securing the cover to the cylinder block. If the cover is stuck, it will be necessary to gently prise away, but take care not to distort the flanges. In replacing, a new washer should always be used, also be sure the cover has not been damaged in the removal, otherwise a tight joint cannot be secured. With the push-rods removed it is possible to inspect the tappets for pitting on the face coming in contact with the cam, although wear is somewhat improbable; but look for scores on the walls of the tappets caused by dirty crankcase oil.

Pistons

The type of piston used on this engine is aluminium alloy, tin plated, oval ground, tapered split skirt, and specially shaped crown.

Four grades of pistons are supplied, as follows :

2·41860–2·41835 in. stamped " Y " on the crown,
2·41885–2·41860-in. stamped " TY " on the crown,
2·41910–2·41885-in. stamped " W " on the crown, and
2·41935–2·41910-in. stamped " TW " on the crown.

The following oversize pistons can be obtained from the makers :

·003 in., ·005 in., ·010 in., ·020 in., ·030 in., and ·040 in. These oversizes are machined to a tolerance of ·001 in.

The piston clearance is		·0025–·002 in.
Piston-ring width :	Compression	·104 in.
	Internal step	·104 in.
	Scraper	·110 in.
Clearance in groove :	Compression	·0035 in. maximum
	Internal step	·003 in. ,,
	Scraper	·003 in. ,,
Ring gap for all rings		·0015–·008 in.

All compression rings must be fitted with the side marked " top " towards the crown of the piston, also it must be noted that the rings should be obtained from the makers on account of special ring pressure. Ordinary rings purchased without special instruction as to their particular use will lead to faulty oiling.

The gudgeon-pin diameter is ·625–·6245 in., and the fit in the piston is " light hand-push fit."

Connecting Rods

Directions for fitting, etc., are given under the section on the Ten, but as the sizes are different only significant data are given :

Length of connecting rod (centre to centre)	6·666 in.
Diameter of big-end bearing	1·875 in.
Width of big-end	1·038 in.
End or side float	·010 in.

Vibration Damper

A vibration damper is incorporated on the crankshaft, and the pulley consists of two flanges, one of which is keyed to the crankshaft and the other mounted on six rubber bushes, being retained in position by means of a flat metal plate and six bolts.

It will be observed that the damper is allowed a certain amount of flexibility in relation to the fixed flange on account of the rubber bushes, and thus absorbs the crankshaft impulses.

Removing Pulley Fixed Flange

Removal of the crankshaft pulley needs little explanation, with either radiator in position or removed, specially if Britool No. 965 is used. If the radiator has not been removed, jack up the front of the car and remove the fan belt. Using Britool No. 1048, remove the two cheeseheaded screws securing the splash guards to the centre of the cross-member, slacken off the two nuts which secure the radiator-shell brackets and also the outer edges of the splash guards to the front cross-member. The splash guards can then be swung forward as far as possible. Remove the six setscrews securing the vibration damper to the crankshaft pulley. Use Britool Pulley Drawer No. 965.

When replacing the pulley it is suggested that the operator use tool No. 839 ; this will obviate damage to pulley and ensure correct alignment. At this stage the vibration damper can also be removed.

Timing Chain and Wheels

Chain pitch	$\frac{3}{8}$ in.
Type	Duplex roller
Number of links (pitches)	50
Width	·9375 in.
Crankshaft sprocket	18 teeth
Camshaft chain wheel	36 teeth

To remove the camshaft, first remove the crankshaft pulley, then the timing cover and distributor, push-rod cover and ventilator pipe, also the push-rods, windscreen-wiper drive housing, tappets and petrol pump. At this point examine the timing chain for slackness, then remove the

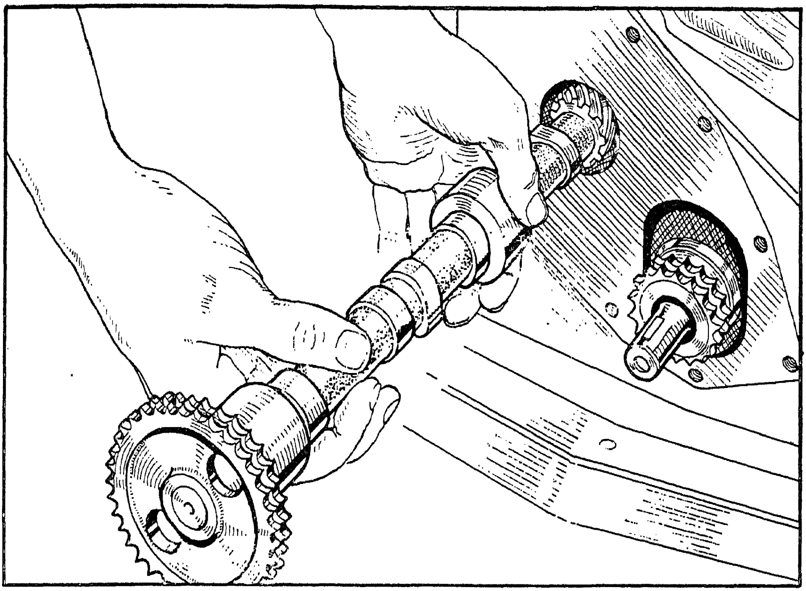


Fig. 4.—REMOVING CAMSHAFT—ENGINE IN POSITION

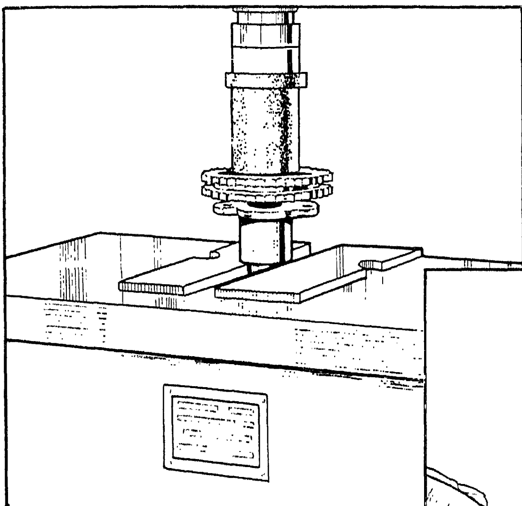


Fig. 4A (*left*).—PRESSING ON CAMSHAFT GEAR

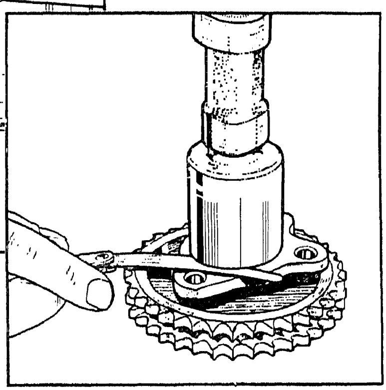


Fig. 4B (*right*)—CHECKING FOR CAMSHAFT END-FLOAT

chain. The ends of the chain are connected with a special link, the outer-side plate of which is polished to distinguish it from the other links. This link, together with its two pins, is prevented from working out on the forward side of the chain by a small U-shaped retaining clip which is sprung into two grooves machined round the inner extremities of the two link pins. To remove this clip, push the ends of the legs with the end of a screwdriver along the direction of the chain, withdraw the link and collect the back plate and centre plate.

Removing Camshaft

The camshaft is located by a thrust-plate behind the chain wheel, the plate being held in position by three setscrews which can be reached through the two holes in the chain wheel. Now withdraw the camshaft very gently. It will probably be necessary to rotate it backwards and forwards slightly in order to free the cams from the camshaft bearings. As the camshaft bearings are white-enamelled and the cams have sharp edges, any haste or roughness will damage the bearings.

The chain wheel can now be removed from the camshaft by the aid of a press, taking care to keep the thrust-plate clear of the bed of the press and clear of the key as the shaft is pressed out. When refitting, ensure the thrust-plate is fitted with the chamfer towards the camshaft front journal. Press on the camshaft chain wheel—timing mark uppermost—and allow a clearance between wheel and thrust washer of ·004–·0025 in.

Some difficulty may be experienced in replacing the camshaft, therefore " go gently " in order to avoid scoring the soft bearings.

Before assembling the chain be sure the timing marks on the crankshaft pinion and the timing chain wheel are correctly positioned. Place a small straight-edge across the centres of the crankshaft and camshaft and rotate both until the timing marks are parallel with the straight-edge, and also directly adjacent and in line with each other. The timing chain can now be fitted, but taking care the legs of the connecting fastener are trailing, viz., at the rear of the direction of travel. Check the timing carefully before further assembling. Do not forget to fit the oil deflector with the concave side to the front of the engine.

Hereunder is given the camshaft bearing data so that they can be easily recognised :

Camshaft bearings :	1	2	3	4
Diameter . . .	1·823 in.	1·7922 in.	1·761 in.	1·567 in.
Length . . .	1·53125 in.	1·000 in.	1·000 in.	1·90625 in.

Diametral clearance is ·004–·0025 in.
End-float (controlled by thrust-plate) is ·004–·0025 in.

If it becomes necessary to renew either the front or front intermediate, or the rear intermediate, camshaft bearings, the operation can be performed without removing the engine from the frame, if Britool Set No. 997 is utilised. If the rear-camshaft bearing has to be renewed, it will be

necessary to take the engine from the frame. If camshaft bearings have to be renewed, be careful to line up the oil holes correctly.

Crankshaft and Bearings

Data

Crankshaft Journal	1	2	3	4
Diameter .	2·0585–2·0575 in.	2·1205–2·1195 in.	2·1825–2·1815 in.	2·2455–2·2445 in.
Length .	2 in.	1·363 in.	1·411 in.	2·105 in.
Crankshaft Bearings				
Diameter .	2·0605–2·0593 in.	2·1225–2·12135 in.	2·1845–2·18335 in.	2·2475–2·24635 in.
Length .	1·59375 in.	1·357 in.	1·15625 in.	1·8125 in.

Crank Pins, diameter, 1·8735–1·8725 in.
width, 1·256–1·253 in.
End-float of crankshaft (controlled by centre main bearing) ·008–·002 in.

The crankshaft cannot be removed with the engine in the frame.

After the engine is removed and placed on a stand it will be necessary to remove the gearbox, clutch, sump, timing chain, crankshaft chain wheel, and oil pump, also the connecting rods and pistons. Without removing the head, disconnect all connecting-rod caps and replace them loosely on their respective rods and lower as far as possible in the bores. There is no danger of the rings expanding in the combustion chamber. Remove the four bearing caps, which are tightly dowelled to the crankcase face. They should be removed by tapping lightly with a hammer and pulling the cap at the same time away from the block. In the case of the rear bearing it will be necessary to remove the engine centre support insulator shield and its two centre screws. If the crankshaft is not worn, it should not be necessary to scrape in the new bearings, but undersize bearings can be obtained from the makers at ·010 in., ·020 in., and ·030 in. undersize.

The crankcase front plate should always be checked for cracks and buckles. It can easily be straightened by hammering between hard pieces of wood. As only a thin paper washer is used when refitting, it is essential that the plate is true.

Removal of Engine

If the engine is to be removed, the oil should be drained from the sump, and the positive battery terminal taken off and laid clear. Drain the water-cooling system by opening the tap situated below the radiator-outlet pipe, also the one in the cylinder block at the rear of the dynamo. Flush the whole water system several times if the engine is to be out of the frame for any time. The residue in the block is likely to harden and eventually, when it dissolves in lumps, to cause overheating, and it may be thought that the trouble is due to faulty workmanship. Remove the radiator and the front wing assembly. Start on the right-hand side of the engine and release the rear union of the flexible petrol pipe to the pump. Remember that this union must be removed first, as the other end of the pipe has a fixed end and the pipe will have to revolve when

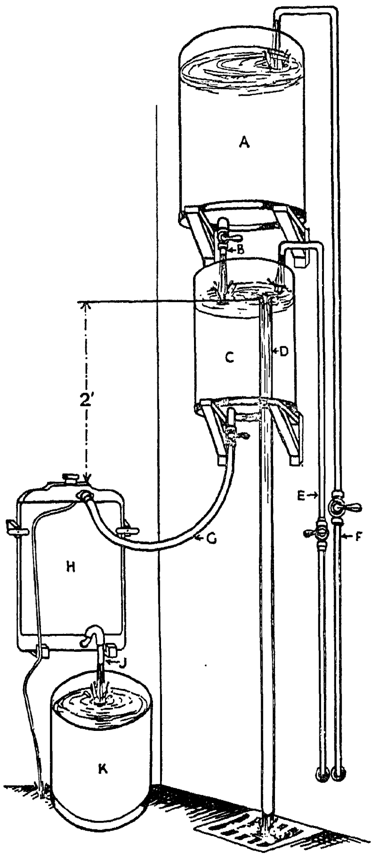


Fig. 5.—FLOW TEST EQUIPMENT

released from the pump. The supporting clip should also be removed. Remove the ignition coil and the windscreen-wiper drive by taking out the two setscrews securing the unit to the crankcase. Disconnect horn wiring, and then remove the horn itself and the ventilator pipe. Disconnect the radiator hoses. Remove the two nuts (one on either side) securing the engine centre support to the frame, and lift away both support and wedges. Remove the clutch pedal pull-off spring from the bracket welded to the engine sump. Lastly, remove the petrol pipe from the petrol pump to the carburettor. Go over to the left-hand side of the engine and disconnect and lay clear the cable connections to the starting motor, dynamo switch, and oil-indicator switch, replacing all nuts and washers to avoid loss. After disconnecting the earthing strip, remove the two bolts and lift the starting motor. Remove the two nuts from the exhaust-pipe flange, lower the pipe and flange, then replace nuts and washer on the studs. Remove accelerator-control rod and disconnect control from carburettor.

It will now be necessary to give attention to the inside of the car and remove the front seats and the flooring. Remove the gearbox and the front universal joint moulded cover. Then remove the four bolts securing the gearbox top cover and the cover itself. Cover the gearbox with a piece of cardboard, so that foreign matter cannot enter whilst being removed and when lying by during operations on the engine. Disconnect the propeller shaft from the gearbox coupling flange.

From underneath the car the clutch-operating cable can be disconnected from the clutch-withdrawal lever, and the engine stay rod from the bracket on the gearbox, afterwards removing the bracket. Remove the four nuts securing the engine rear-mounting insulators to the engine support member. Then remove the engine undershields.

Returning to the front of the engine, remove the radiator splash guards from the front cross-member. Remove the two nuts and spring washers from each front mounting bracket. Remove fan and fan pulley. Now place a rope around the engine with gearbox attached.

Work on Engine

Without attempting to show the operator his work, it has been found from experience that the undermentioned sequence is the most suitable for carrying out work on the engine.

Remove : Clutch-housing lower cover, gearbox, oil pipes, distributor vacuum control suction pipe, induction and exhaust manifolds with carburettor, dynamo, plugs and distributor, petrol pump, push-rod and rocker covers, rocker gear complete, push-rods and tappets, cylinder head, water pump, crankshaft pulley, timing cover, timing chain and camshaft assembly, and crankcase plate, turn engine over in stand and remove connecting rods and pistons, clutch from flywheel, main-bearing caps and crankshaft, and main-bearing liners from crankcase.

Petrol System

The carburettor fitted in the Zenith Downdraught Model 30 VIG-2. The settings are as follows :

Choke tube diameter	22 mm.
Main jet	80 mm.
Compensating jet	90 mm.
Slow-running jet	50 mm.
Pump jet	70 mm.
Progression drilling	1 m.
Needle-seat diameter	1·5 mm
Air bleed, full throttle	1·9 mm

Clutch

The clutch is dealt with under that section describing Borg & Beck clutches, but dimensions, although following standard practice, will be of assistance to the repairer.

Thickness of clutch disc	·375 in.
Rivets	$12\frac{15}{64}$ in. × ·143 in Brass tubular
Clutch lining : thickness	·130 in.
Clutch lining : external diameter	8 in.
Clutch lining : internal diameter	5·260 in.
Number of clutch springs	6
Free travel of clutch pedal	1 in.

Engine Cooling System

The practice herein explained is followed in all recent Vauxhall models, therefore is well worth space ; also Fig. 5 is an excellent example of a testing plant for radiators :

Data

Capacity of cooling system .	16 pints
Water-pump spindle : diameter	·6267 in.
Water-pump spindle : length	4·15625 in.
Fan-pulley diameter .	4·1875 in.
Fan belt : depth . .	·4375 in.
Fan belt : width	·572 in.
Fan belt : angle of " V "	32°

It will be noted that the fan-pulley angle is 32° and not 28°, the usual practice. To remove the water pump, remove the lower water connection, slacken off the dynamo and remove the belt. Remove the fan from the pulley, and then the three bolts which secure the water pump to the cylinder head. To dismantle, remove the rear plate from the pump and the circlip from the end of the spindle. Knock off the tapered cotter pin which secures the ball race, and press out the pump spindle from the rear to the front end. The spring-loaded rubber seal and fibre pad can then be removed. The shaft is supplied as an assembly, with bearings and pulley flange. The face of the pulley flange must be true within ·004 in. The pump rotor must be assembled in the following manner : after assembling the oil seal, pump shaft, and the bearing, the pump must be stood on end so that the fan pulley attachment is at the bottom, then place the impeller on the shaft and press it on a small distance, and rotate the shaft to prove that the impeller is on square. This is very important, as the impeller can be split even if pressed on only slightly out of truth. Continue pressing a small distance at a time and checking for squareness, until the impeller is well on the shaft. Place a feeler strip between the vanes on the front face of the impeller and the pump housing, and press on the impeller until it butts lightly against the feeler and gives the required clearance of ·013 in. The rubber seal is fitted with the large inside diameter to the front of the pump body, and the fibre seal with the unchamfered edge towards the bearing. At the same time, ensure that the fibre-seal locating peg engages in its groove in the housing. Always fit a new washer between the rear of the pump and the plate.

Thermostat

To remove the thermostat detach the top water-hose connections and the thermostat snap-ring. Dismantling is not recommended, owing to the difficulty of adjustment. To test its efficiency, however, place the thermostat in a saucepan over a gas-ring, and take the temperature with a first-class thermometer during the heating. The valve should commence to open at 160°–165° F., and be fully open when the temperature reaches 190° F. The valve opening, or lift, should be $\frac{11}{32}$ in. Overheating of the engine may cause damage to the bellows and force the valve to remain permanently open.

Radiator-flow Test

The radiator-flow test apparatus shown in Fig. 5 should come in useful for other radiators, therefore is described in full : fix two brackets to the

wall upon which the radiator (H) can be rested. A small reservoir tank (C), made by cutting about 6 in. from the top of a 5-gallon oil drum, is fitted on the wall above the radiator. From the bottom of this tank a 1½-in. internal diameter stop-cock controls the flow of water, which is led by means of a rubber hose (G) of the same internal diameter to the top of the radiator. Some form of overflow must be provided for this reservoir tank, and can be constructed by utilising an old exhaust pipe soldered into the tank so that the distance from the top of the overflow pipe (D) to the top of the radiator is exactly 2 ft. This dimension is of the utmost importance, as it represents the height of the head of water above the radiator when flow testing, and the flow-test figures given later on will be applicable only if this condition is maintained. Fit the overflow pipe so that inlet is 2 or 3 in. below the rim of the reservoir tank (C), thus preventing splashing over when filling with water, as the tank has to be maintained with the water level up to the top of the overflow pipe throughout the whole of the flow-test procedure. This is necessary to ensure a constant head of water.

Depending on the variation of the main water supply in different districts, it is possible that difficulty may be experienced in maintaining a water level up to this point, and to overcome this a further 10-gallon drum (A) may be mounted above the reservoir (C) to augment the supply. For districts where water is supplied under high pressure the second tank (A) is not required. If, however, it is necessary to use this second tank (A), it should be provided with a 2–2½-in. stop-cock fitted at the bottom, so that the water contained in the tank can be turned on to fall directly into the smaller tank (C). For measuring the quantity of water passing through the radiator under test, a third drum of 5 gallons capacity (K) will be needed, and a short length of rubber hose (J) will be necessary for directing the escaping water from the radiator into the tank (K).

To carry out the test the radiator (H), Fig. 5, is clamped in position on the brackets, and the flexible rubber feed pipe (G) from the reservoir tank (C) connected to the water-inlet pipe of the radiator, as shown. The water-supply control tap (E) is then turned on to fill the reservoir tank (C) and maintain this tank in an overflowing condition, so as to produce a constant head of water during the test. If it is found there is insufficient flow of water from the " main " (E), the stop-cock (B) should be turned to give the necessary extra supply from the tank (A) and maintain the head necessary in tank (C). To ensure that water is passing through all the passages of the radiator and that the top tank is properly filled, temporarily seal the outlet pipe with the hand until a steady flow emerges from the overflow pipe, then release the radiator outlet pipe. With a stop-watch in the hand, place an empty 5-gallon drum (K) under the radiator outlet, starting the watch as the water from the radiator commences to enter the drum (K). Carefully record the time, which, in case of a satisfactory radiator, should be 25 seconds. If an old radiator

is being submitted to the test, it is probable that some slight corrosion may have taken place, when the time may be slightly greater. Providing the difference does not amount to more than 1 or 2 seconds longer it is not likely that overheating will take place. Should the figure reach 5 seconds or more, the radiator should be internally overhauled.

Gearbox

The gearbox follows the general practice of the Vauxhall Company, excepting that ratios and dimensions are somewhat different. The data are as follows:

First-speed ratio	3·43 to 1
Second-speed ratio	1·64 to 1
Top speed	Direct
Reverse-speed ratio	3·56 to 1
Needle rollers on layshaft	54
Needle rollers on first and second mainshaft gear	176, length $\frac{27}{32}$ in.
Needle rollers on mainshaft spigot	24, length $\frac{5}{8}$ in.
End-float of layshaft cluster	·020 in. maximum
End-float on first and second gears	·006 in. maximum
Capacity of box	$1\frac{1}{4}$ pints

A.E.C. PETROL ENGINE, CLUTCH, AND GEARBOX

A.E.C. Matador Mark II, Regent, Mammoth Major, and Monarch Mark II petrol-engines are of the high-efficiency, high-speed type, and have a speed range of from 300 r.p.m. to over 3,000 r.p.m.

With the exception of the Monarch Mark II (an 80-b.h.p. four-cylinder engine), each of the above engines has a maximum output of 120 b.h.p.

Cylinder Head

The cylinder head carries the camshaft and valve-gear mechanism, and has screwed detachable valve seatings fitted for the exhaust valves. These seatings are made of a special bronze alloy.

Retiming Device

To enable the timing to be quickly and correctly picked up when the head is replaced, a locking device (*see* Fig. 1) is fitted to hold the crankshaft with the pistons of the front and rear cylinders at the top-dead-centre position. An indicator (*see* Fig. 2) is fitted to the timing wheel to show when the camshaft is in the position which corresponds with the forward piston at the top dead centre of the compression stroke.

The locking device for the crankshaft consists of a spring-loaded T-headed pin carried in a guide screwed into the flywheel housing, and arranged to engage in a hole drilled in the flywheel, which is thus kept from moving.

To engage this lock withdraw the T from the shallow slot, turn it through a right angle, and allow it to drop into the deeper one. The engine should then be turned very slowly until the pin is heard to snap into the hole in the flywheel.

The camshaft indicator (*see* Fig. 2) consists of a line cut across the tops of the teeth of the timing wheel, and arranged to come opposite to two arrows, placed one each side of a little window in the timing-wheel cover, at the same time as the piston of the forward cylinder reaches its top dead centre.

The crankshaft can, of course, be locked with either the forward or rear piston at the end of its compression stroke, but, as the camshaft runs at half engine speed, the line across the teeth of the timing wheel will be visible only when the forward piston is in this position. It is

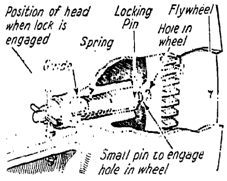


Fig. 1.—CRANKSHAFT LOCKING DEVICE

This is fitted to hold the crankshaft with the pistons of the front and rear cylinders at the T.D.C. position.

therefore impossible to be confused as to which position the crankshaft should be locked.

Having locked the crankshaft in the correct position, the cylinder head may then be removed and, if the crankshaft is undisturbed, it is necessary only to see that the line on the timing wheel is opposite the arrows before the timing wheels are meshed to obtain the correct timing when it is replaced.

Removal of Cylinder Head

Remove the cylinder-head cover, and lock the crankshaft in position as described above. When disconnecting the top water pipe, do not disturb the rubber connection but break the flanged joint. Also break the carburettor flange and leave the carburettor in position on the chassis.

The autovac and servo vacuum pipes also must be disconnected, as well as the exhaust-pipe flange. Remove the nuts which hold the rocker-shaft brackets in position (*see* Fig. 3), and lift off the two groups of rockers complete.

The radiator stay is secured to the engine by the front two cylinder-head nuts, and after these nuts have been removed and the nuts on the bolts on either side of the radiator stay slackened off, the stay should be swung upwards and kept out of the way.

On no account should the stay be disconnected from the radiator.

There are two conical washers between the stay and the cylinder head which must be removed and placed for safety with the other small parts before the head is lifted off.

Two special jacknuts are fitted to facilitate the removal of the head. These nuts are so arranged that as they are unscrewed they will lift the head clear of the cylinder. These two nuts, therefore, must *not be unscrewed until all the other nuts, including the four which secure the timing case to the cylinder head, have been removed.*

After all the other nuts have been removed, unscrew the two jacknuts evenly until the nuts are disengaged from the studs.

For lifting purposes an eyebolt is fitted at each end of the cylinder head, and a sling is supplied in the tool-kit.

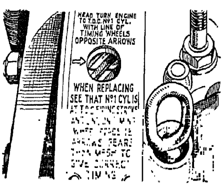


Fig. —CAMSHAFT INDICATOR FOR RETIMING ENGINE

Renewal of Valve Seatings

The exhaust-valve seatings may be renewed when, after prolonged service, the seating has worn. The seatings are screwed into the cylinder head, and a special spanner is supplied in the garage equipment for fitting these seatings.

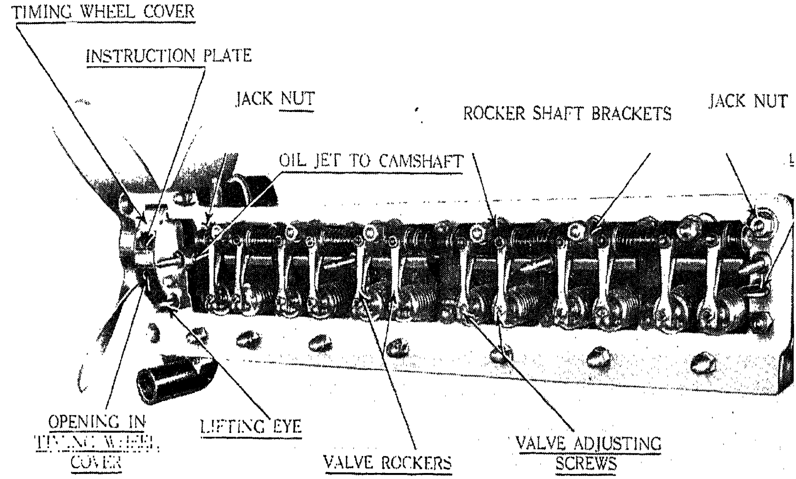


Fig. 3.—VIEW OF CYLINDER HEAD

The threads of the seating are made large and should be a tight fit in the cylinder head, and should be screwed in so that they are up hard on the bottom of the counterbored portion of the valve port, and the seating filed down flush with the cylinder head.

The seating may now be cut with a valve-seating cutter, spigoting off the valve-guide hole.

Replacing Cylinder Head

When replacing the cylinder head, make certain that the crankshaft is still held in the timing lock, and, by examining the magneto, that the forward piston is in the firing position. Replacement of the cylinder head is the same as that described for the 80-h.p. oil-engine on p. 433.

The correct timing of the engine is :

Inlet valve opens	Top dead centre.
,, ,, closes	$7\frac{1}{4}$ in. after b.d.c.
Exhaust valve opens	6 in. before b.d.c.
,, ,, closes	$1\frac{1}{4}$ in. after t.d.c.

The above measurements are on the outside diameter of the flywheel.

To give this timing, the clearance for both valves should be ·008 in. (·012 in. in the case of the Monarch Mark II), and must be measured with the rocker right on the back of the cam.

The crankshaft lock is withdrawn by drawing it back by the T-handle and turning it through a right angle, and allowing the T to drop into the *shallow* slot in the head of the socket. Always give the engine a swing by hand, as a check that the lock has been withdrawn.

Run the engine, and then give a further nip to all the cylinder-head nuts while it is still hot. The valve clearance should again be checked, as the valves may settle a little on their seats and so reduce the clearance slightly.

To Remove the Camshaft

Removal and replacement of the camshaft bearings are accomplished in the same way as described on p. 434 for the A.E.C. 80-h.p. oil-engine. The fit of the bearings is also the same.

Connecting Rods

The big-end bearings are formed by die-casting the Babbit directly into the rod, and shims are provided for the easy adjustment of the bearings which, except for a short "mud groove" at the joint between the rod and cap, have a plain surface free from any grooving.

Connecting rods are made to a weight of from 52 to 53 oz. at the crankpin end, and from 14 to 15 oz. at the gudgeon-pin end, and are selected so that all the rods of the engine are within half an ounce of each other at each end.

To Remove Pistons and Connecting Rod

The pistons must be removed by passing the connecting rod up through the cylinders.

When removing the connecting-rod caps, take care not to damage the shims, which must be replaced exactly as they were removed from the engine.

When replacing the pistons and rods, the split of the piston must go towards the nearside of the engine. The clamping bolt at the top of the rod should be on the nearside of the engine. The pistons and rods are numbered in sequence, counting from the forward end, and must be refitted to the cylinders from which they were removed.

Piston-ring Fits and Clearance

When new, the clearance of the top ring in its groove is from ·003 in. to ·0045 in.; the others, including the scraper ring, have a clearance of ·002 in. to ·0035 in.

Rings which show blackened or discoloured patches, on either the working surfaces or the sides, should at once be replaced by new ones.

When fitting new rings, a gap clearance of ·008 in. should be allowed when the ring is square in the cylinder.

The clearance at the skirt of the piston, when new, is from ·0035 in. to ·005 in.

Where stepped scraper rings are fitted, they must be placed in the groove so that the raised step which bears on the cylinder is towards the top of the piston.

Gudgeon-pin Fit

gudgeon-pin in the piston should be such that, when the piston is at ordinary room temperature, the pin can be forced in by the pressure of the two thumbs. On no account should the pistons be reamed out. When fitting new pins, the pins must be selected to give the correct fit.

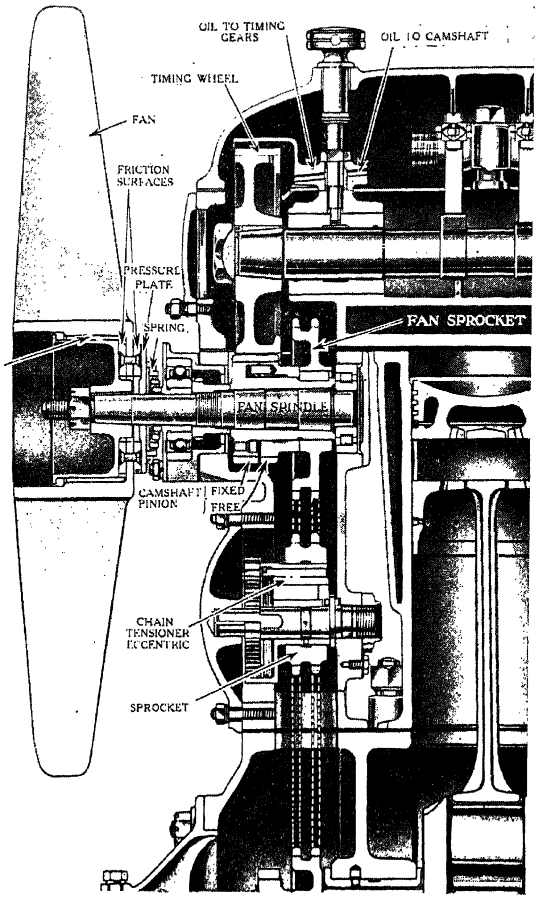


Fig. 4.—ARRANGEMENT OF FAN AND CAMSHAFT DRIVES

Crankpin Bearings

To enable adjustments to be made, three shims are fitted each side between the rod and cap. These shims are ·003 in., ·005 in., and ·010 in. thick, and thus allow of an adjustment of ·002 in. The surface of the rod or cap must on no account be filed. End play between rod and crank should be ·008 in. when new.

As the rods are of alloy steel, special care is necessary when metalling. Rods which require rebabbiting should be returned to the factory for this purpose, or be exchanged for new ones.

To Remove Cylinder Block

After removing the cylinder head, remove the generator and magneto and take out the long bolt which passes through the water-inlet pipe, timing case, and water-pump discharge.

Disconnect the control rods from the hand-levers in the cab.

On removing the nuts which hold the block to the crankcase, the

block can be lifted off. It is highly desirable that the pistons be drawn before the block is lifted.

Before replacing the block, make certain that the paper gasket between the cylinders and the crankcase is in good condition. If a proper gasket is not available one may be cut from thick ordinary paper, but see that the rectangular opening at the rear end of the cylinder block for the cylinder-head oil return is not closed up.

Operations on the chain tensioner, timing chain, and camshaft pinion are as already described on pp. 437–440.

For particulars of fan adjustment and water pump construction, the reader is referred to pp. 421 and 422.

Oil-pressure Regulation

The oil pressure varies in accordance with the load on the engine, is effected by interconnecting the relief valve and the accelerator pedal in such a way that, as the pedal is depressed, the spring load on the relief valve is increased, thus increasing the pressure in the main gallery pipe.

The relief valve is situated inside the crankcase on the offside, and a tappet rod, which depresses the spring, is carried up through the top of the crankcase, where it is operated by an arm on the throttle lever.

Oil Filter

The filter consists of a thick felt cylinder with a gauze outer cover, and is carried in a chamber partitioned off from the sump. Into this chamber the oil to the camshaft is fed, and passes radially inwards through the felt cylinder, the cleaned oil then being fed to the cylinder head.

The filter can be withdrawn from the crankcase (by removing the cover which is on the offside of the crankcase) without losing any oil other than that actually in the filter chamber itself.

In order to clean the filter, the outer gauze should be scraped and the whole washed in petrol. Before replacing it in the crankcase, squeeze the felt to remove as much of the petrol as possible, allow it to drain for as long as possible, and soak it in a bucket of clean oil.

The oil-pump suction is taken from a strainer, to prevent any foreign particles or large pieces of carbon from being fed into the bearings.

This strainer is carried on a removable plate bolted to the bottom of the sump, and is therefore easily accessible for cleaning.

As an additional safeguard against injury to the bearings, a magnet is fitted on the sump plate beneath the strainer. This magnet will collect the particles of iron and steel which are inevitably worn from the various parts, and prevent them from being circulated with the oil and causing increased wear. When changing the oil, both the strainer and the magnet should be removed from the sump and cleaned.

During the annual overhaul the hollow crankpins should be cleaned out as, after a protracted period of operation, dirt from the oil will tend to collect inside.

The ends of the crankpins are closed by means of steel caps which are held in place by a bolt running through the centre of the pin. These caps should be removed and the hollows cleaned out. When replacing the caps, see that the copper and asbestos washers which make the joint oil-tight have not been damaged or displaced. The bolt must be screwed up tight, copper washers being fitted under both the nut and the head of the bolt, and particular care must be taken that a good job is made, otherwise the failure of the connecting-rod bearing may result.

The oil pump-crankshaft centres are adjusted by means of shims to give a small amount of backlash in the driving gears. Care must, therefore, be taken to replace the shims if the oil pump is removed.

Adjustment of Oil Pressure

The oil pressure is correctly adjusted at the factory and should require readjustment only if the parts have been taken apart.

The correct pressures for the oil are as follows :

Pressure when idling and the engine is hot, 5–12 lb. per square inch.

Pressure at full throttle with engine hot, 45–60 lb. per square inch.

To adjust the pressures to these figures, pull the hand throttle lever to the closed position and, after making sure that the plunger is quite free by pressing it down by hand a few times, adjust the screw so that it only just touches but does not depress the end of the plunger. A very thin feeler, ·002 in. or ·003 in., used as when adjusting valve clearances, is to be recommended. Access to the oil-pressure adjustment on forward-control models is provided for by a small opening in the nearside of the driver's cab.

Excessive oil pressure at light loads tends to produce a high oil consumption, and it is therefore advisable that pressures higher than the maximum quoted should be avoided.

Magneto Timing

The types of magneto most generally fitted to the A.E.C. engine are the Simms S.R.6.L.E. and the Scintilla G.N.6.S. Both types are fitted with automatic advance in addition to the hand control.

The magneto should be timed so that ignition takes place on top dead centre when both the hand and automatic advance are fully retarded.

THE CLUTCH

A single-plate clutch is used on all A.E.C. vehicles.

The friction discs are riveted, one on either side of the driving plate, so that the clutch can be relined without removing the flywheel, whilst a detachable plate spigoted into the flywheel relieves the flywheel of any wear occasioned by slipping.

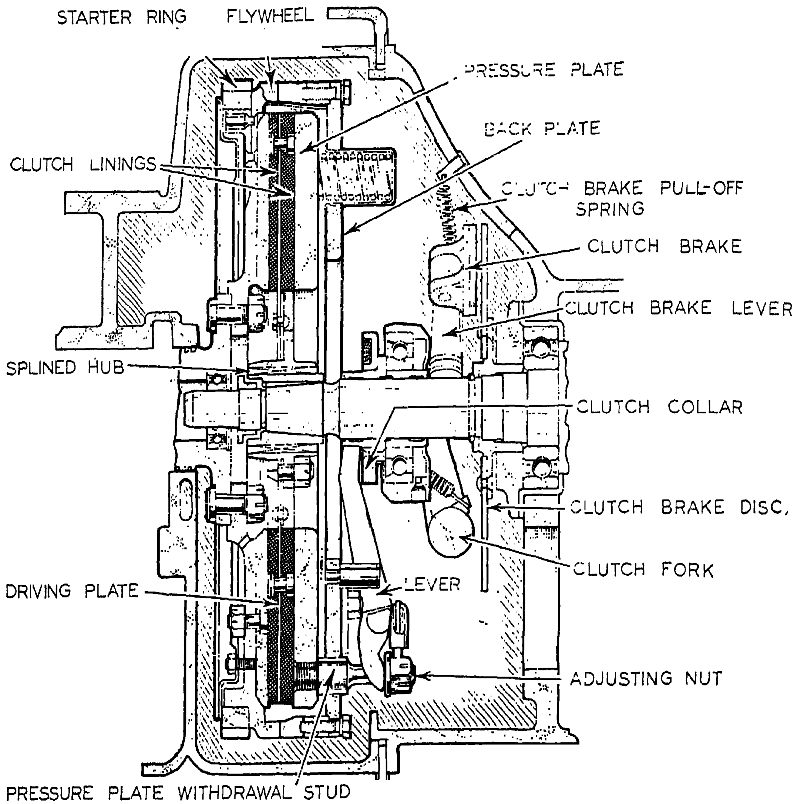


Fig. 5.—ARRANGEMENT OF CLUTCH

The linings when new are of different thicknesses, this being done to even up the wearing life of each, and it is very important that the thicker of the two is towards the pressure plate (Fig. 5).

The clutch disc drives through a broached hub which engages with splines on the clutch shaft.

Provision is made for the renewal, when worn, of the splines by keying a detachable hub on a taper cut on the clutch shaft.

The clutch is withdrawn by three levers which have been very carefully adjusted so that equal pressure is applied to each.

The clutch collar is carried upon the clutch shaft by a graphite-lined bushing, which is a loose fit on the shaft. This bushing comes into operation only when the clutch is withdrawn, and is designed to run dry. The graphite provides all the lubrication that is necessary. A ball bearing mounted on the clutch collar takes the thrust from the clutch

fork. The outer race of this bearing is stationary at all times, being fitted with a cage against which the clutch fork operates.

The clutch brake is operated through a spring plunger mounted on the clutch lever. The motion of the clutch lever brings the plunger into contact with one end of a second lever pivoted about its centre and carrying on its other end a plate faced with friction material. This plate is brought into contact with a disc mounted on the clutch spindle, and thus provides the braking action, the magnitude of which is governed by the load on the plunger spring.

Clutch Adjustment and Maintenance

Note carefully that the adjustment of the nuts against which the declutching levers act must not be disturbed except under the conditions given below. They must not be used to adjust for liner wear.

As the clutch linings wear, the clutch pedal rises and will, in time, come against the tubular bracket, carrying the accelerator pedal spindle across to the offside. The pedal must be allowed a free upward motion of 1 in. at all times, and this is adjusted by the large wingnut found at the bottom of the lever.

The ball bearing of the clutch collar should be sparingly lubricated with a hard grease once every week. Only a small quantity must be applied, otherwise trouble will be experienced from grease getting into the graphite-lubricated bush.

The clutch brake should be adjusted, by means of the adjusting screw, so that the outer end of the clutch-brake lever can be rattled about $\frac{1}{8}$ in.

If the Clutch Slips

Pull the pedal upwards. There should be about 1 in. free motion. If this is not the case, adjust by slacking off the brass wingnut at the base of the pedal lever.

If the pedal has ample free motion :

(1) The clutch disc may be tight on the splines.

(2) The clutch collar may be sticking on the shaft.

(3) The friction discs may have become oily—wash out with paraffin.

(4) The withdrawal pin may be sticking in the cover plates due to rust, etc.

(5) The friction discs may be worn out, as will be indicated by the clutch collar being back against the clutch-brake disc.

If clutch does not fully disengage, causing difficulty in changing speed and the gears to drag :

(1) Feel the outer end of the clutch-brake lever (*see* Fig. 5), which can be reached underneath the chassis on the offside. It should be possible to rattle the lever forward and backwards about $\frac{1}{16}$ in. to $\frac{1}{8}$ in.

(2) The adjustment of the declutching levers may be too close. Readjust the nuts by screwing up each equally. Turn each nut one

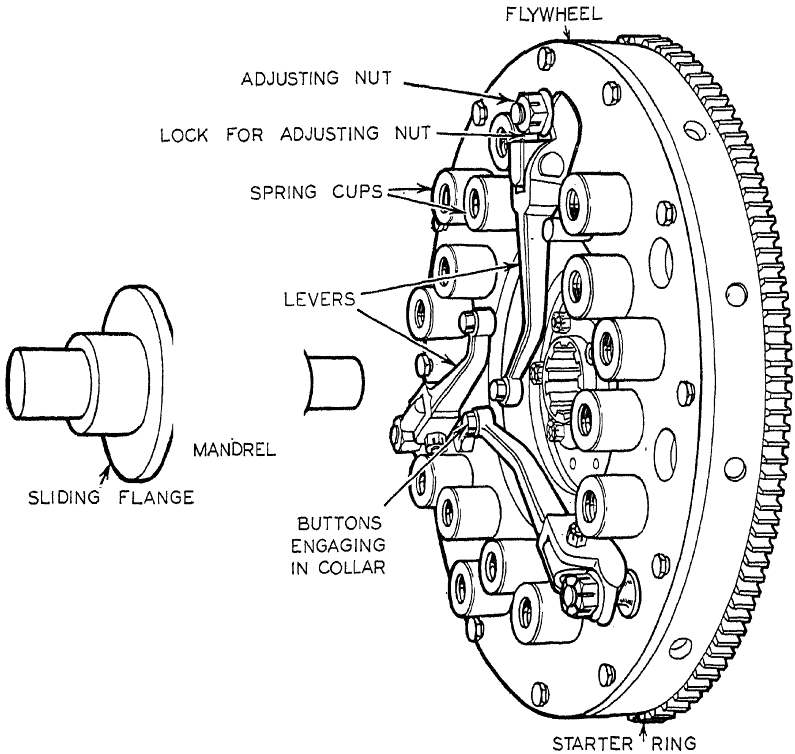


Fig. 6.—INSERTING MANDREL FOR ADJUSTING CLUTCH

facet and then see whether the desired improvement has been obtained. Mark each nut with chalk, as it is adjusted, to avoid mistakes, as only one nut at a time is visible.

It is essential that they should be adjusted equally.

To Remove Clutch

Remove the gearbox. Remove two of the screws which hold the cover plate in position, and substitute two long studs 3/8 B.S.F. and nuts, screwing the nuts fingertight against the cover plate.

Remove the remainder of the cover-plate screws, and then unscrew evenly the nuts on the two studs just fitted, and so release the springs.

The cover plate, pressure plate, and clutch disc can then be lifted off.

The clutch brake, collar, and shaft will come away with the gearbox.

To Reline Clutch

Using the driving plate as a jig, centre the linings carefully and drill for the rivet holes. The linings must then be recessed ($\frac{19}{32}$-in. diameter

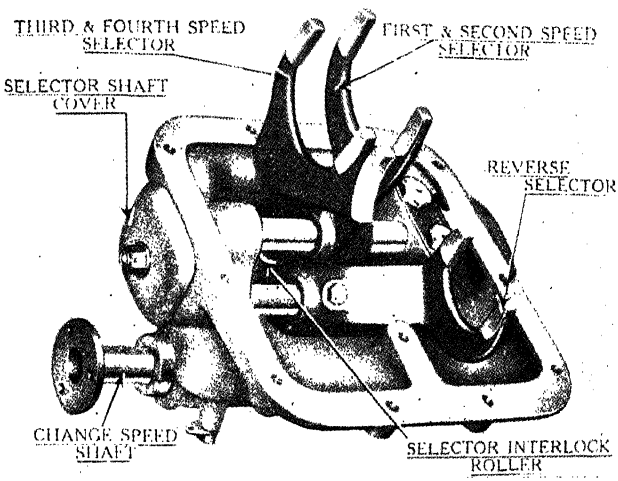


Fig. 7.—THE SELECTOR FORKS

by $\frac{5}{32}$ in. deep in the case of the thin liner, and $\frac{19}{32}$-in. diameter by $\frac{9}{32}$ in. deep for the thick one) for the rivet head and riveted one on either side of the driving plate.

Use $\frac{1}{4}$-in.-diameter flat-head brass rivets, and rivet over on a brass washer.

To Assemble Clutch

Before assembling the clutch, the recess in the crankshaft containing the clutch pilot bearing must be filled with a good-grade hard grease.

For assembling the clutch, a special gauge is supplied for both centring the clutch plate and adjusting the clutch withdrawal levers. This gauge consists of a sliding flange mounted on a mandrel which is made to fit into the clutch pilot bearing, and also the clutch plate. (*See* Fig. 6).

Place the clutch plate on to the mandrel and insert the end of the mandrel in the pilot bearing. Replace the clutch cover complete, and tighten up the screws securing it to the flywheel.

The clutch plate will now be properly centred in the clutch, so that the clutch shaft can be passed through it into the pilot bearing.

If the clutch has not been relined and the adjustment of the levers has not been in any way interfered with, the gearbox can be replaced without further delay. If this is not the case, the levers must be adjusted carefully, and the satisfactory operation of the clutch will greatly depend upon how this adjustment is made.

When replacing the gearbox, see that the buttons on the declutching levers enter the recesses provided for them in the clutch collar.

To Adjust Declutching Levers

It is essential that the three levers should be adjusted equally in order that the pressure plate may be lifted off the clutch disc the same amount by each of the levers.

Place the mandrel through the clutch disc and into the pilot bearing, and slip on to it the sliding flange with the boss outwards. Slide the flange on until it comes into contact with the buttons on the ends of the withdrawal levers.

The levers must then be adjusted by means of the nuts on the withdrawal studs so that all three levers are just touching the flange and the distance between the clutch disc and the face of the flange is $2\frac{11}{16}$ in.

The nuts are locked automatically by means of a spring plunger mounted in the lever and pressing against the flat of the nut.

To Reline Clutch Brake

The clutch-brake plate can be removed through the inspection hole in the bell housing, and it is therefore unnecessary to disturb anything else.

To remove the plate take out the pin connecting it to the end of the levers, lift the plate out through the opening, and unhook the pull-off spring between the plate and the bell housing.

FLUID FLYWHEEL

If a fluid flywheel is fitted, the oil level should be checked weekly.

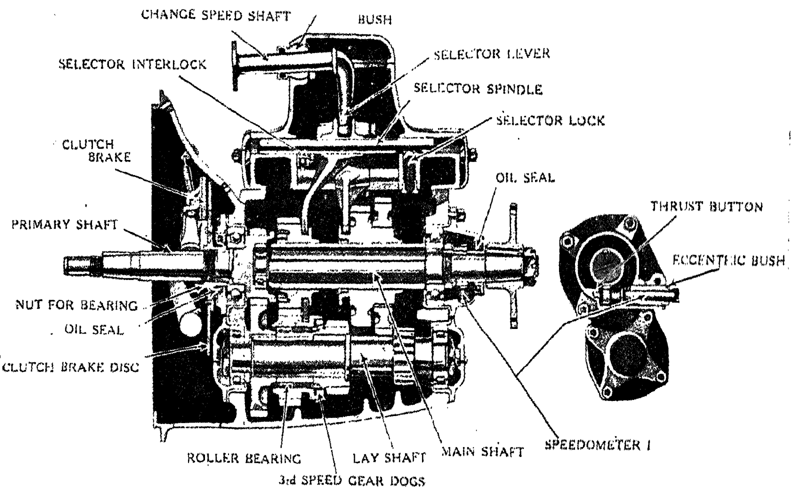


Fig. 8.—ARRANGEMENT OF GEARBOX

Adjustment of Gland Packing

Excessive fluid consumption indicates that the gland packings require attention. In the first case, the adjusting nut should be tightened carefully. Over-tightening of the nut will cause the packings to become overheated and burn.

To Replace Oil-retaining Packing

Should the foregoing procedure fail to remedy the leakage, it will be necessary to replace the packings. It is important that the correct packing be used, which should be obtained from the A.E.C.

Drain flywheel through plug provided. Disconnect front universal coupling, and temporarily secure cardan shaft to the offside of the chassis frame with wire or rope. Remove coupling flange, lift locking tab, and unscrew and remove gland-adjusting nut. Remove old packing and insert new.

Replace gland nut but do not tighten. Grease shank of coupling and replace. Great care should be taken to ensure that the nut is tight and that it makes a good joint with the flange, in order to preclude leakage along the splines. Tighten gland nut until firm, but do not force. Refill flywheel with engine oil and bolt up universal coupling. The gland should again be slightly tightened after the first few hundred miles.

GEARBOX

Stripping and Overhaul—Removal of Selector Forks

The selector mechanism may be removed as a complete unit from the gearbox without disturbing the box in any other way.

On the forward-control models it is necessary first to disconnect the change-speed shaft at the rear coupling, whilst on the normal-control models the clutch-operating rod must be removed, allowing the selector casing to be removed complete with change-speed lever and clutch pedal.

To dismantle the forks, remove the selector locks by unscrewing the two hexagon caps and also removing the two covers over the end of the selector shafts. Remove the locking screws which secure the selectors to their respective shafts, and tap the shafts out through the cover.

The interlock need not be disturbed, but before tapping out the first shaft make certain that the other two have the interlock recess opposite the interlock.

To Align Change-speed Lever and Selector Mechanism

Note that this operation is necessary only on the forward-control models if the gearbox has been changed. Remove the selector cover g. 7).

Bolt up the two couplings, leaving the bolts in the *forward* one just tight enough to hold the coupling steady. Bring the change-speed lever

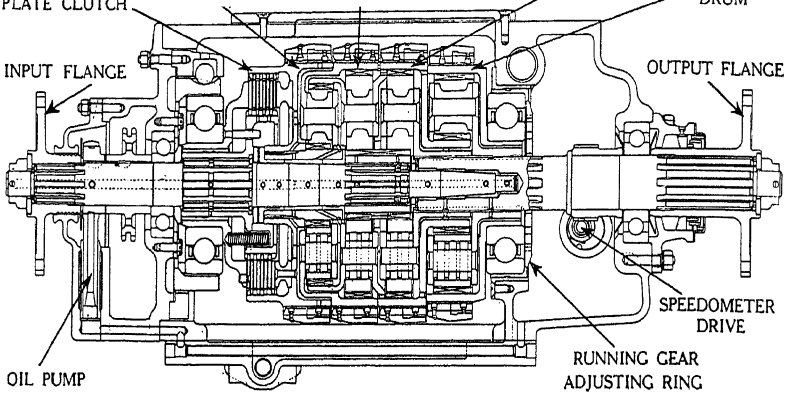


Fig. 9.—ARRANGEMENT OF PRE-SELECTIVE GEARBOX

into the neutral position and push it towards the nearside, to bring it against the reverse latch.

Without moving the change-speed lever, adjust the selector lever until it occupies a central position in the slot in the centre selector.

Tighten up the forward coupling, and check to make certain that nothing has shifted while bolting up.

Removal of Main Shaft and Gears

It is possible to remove shaft and gears while the box is in place in the chassis ; but with the body on, it will probably be found easier first to remove the box and then to do the necessary work.

Remove the cover carrying the selectors and also that on the nearside of the box. If the box is in position in the chassis, disconnect the propeller shaft and move it to one side.

Remove the nuts securing the speedometer-drive casing and draw the shaft out of the gearbox with the speedometer-drive casing in position on it. The two gear units will be stripped off as the shaft is withdrawn, and may be removed through the side cover openings.

Do not remove the driving flange unless it is necessary to replace either the leather packing, the bearing, or the speedometer worm.

To Remove Layshaft

Remove the main shaft as described above, remove the end cover over the rear roller bearing, draw the shaft part way out through the opening until the constant-mesh gear is clear of the pinion and the front end of the shaft is clear of the front bearing, and then bring the shaft out through the opening on the nearside.

An end play of ·008 in. should be allowed for the layshaft.

To Remove Constant-mesh Pinion

Remove the box from the chassis.

Unscrew the nut securing the splined hub on to the tapered clutch shaft, remove the hub and key, draw off the clutch collar.

Remove the lever from the end of the clutch-fork spindle, the bearing at the offside end, and the collar from the nearside end of the clutch-fork spindle. Withdraw the clutch fork by moving it far enough to the offside to disengage the shaft from the nearside bearing, and then bring it out through the bell housing.

Remove the clutch brake.

Remove the nuts securing the cover over the bearing, using for this purpose a box spanner through the holes provided in the clutch-brake disc, and draw out the shaft and pinion with the clutch-brake disc, bearing, and housing cover in place.

The clutch-brake disc is riveted to the nut which secures the bearing to the pinion shaft, and is unscrewed by a special pin spanner provided for this purpose, the thread being left-hand.

The bearing can be driven off the shaft by using a punch through the holes in the pinion provided for this purpose.

To Remove Reverse Pinion

Remove the cover carrying the selector gear. Remove the nut from the end of the pinion shaft, and drive out the shaft towards the rear. When replacing the shaft, care must be taken to see that the snug goes into the recess cut in the boss to receive it.

It should be noted that the reverse pinion is made a slack fit on the spindle, a clearance of ·008 in. being allowed when new.

To Remove Gearbox from Chassis

The gearbox must be moved straight back for about $4\frac{1}{2}$ in. before the complete assembly can be lowered. Do not remove the two $\frac{3}{8}$-in. bolts which secure the engine to the cross-members.

PRE-SELECTIVE GEARBOX

The operation of self-changing gearboxes is dealt with in Vol. I, p. 163. The following notes deal with the adjustment, dismantling, and reassembly of the unit as fitted to A.E.C. vehicles. All adjustments must be made with the engine stationary.

Checking Gear Selection

Should any gear persistently fail to engage, it will in all probability be caused through a derangement of the selector control mechanism.

To check this, disconnect the selector rod at the gearbox end and set the lever on the gearbox to the position for selecting reverse gear, taking care that it is properly located by the spring-loaded plunger operating on the selection quadrant inside the box. Then position the hand lever

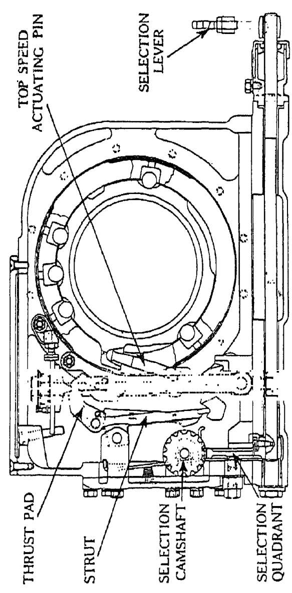


Fig. 10.—Top-speed actuation

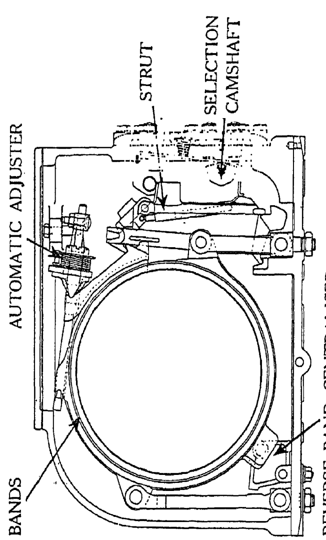


Fig. 11.—Reverse-speed actuation

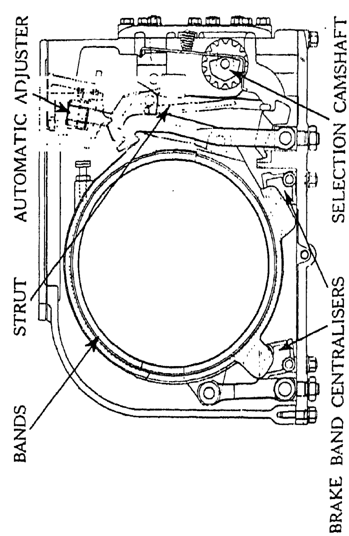


Fig. 12.—1st-, 2nd-, 3rd-speed actuation

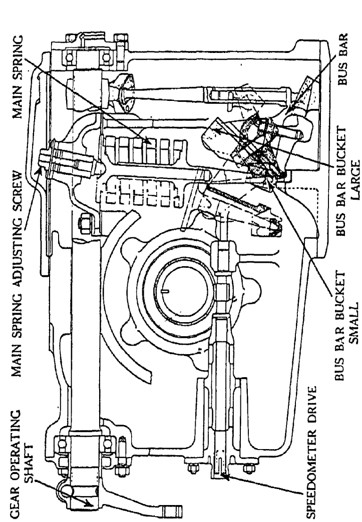


Fig. 13.—Cross-section showing main spring and operating shaft assembly

in reverse (it is necessary to lift the lever bodily to clear the reverse stop in the gate), and adjust the length of rod so that the fork-end pin can be inserted. Provided that the slots in the gate are correct, the position of the other gears should follow automatically.

All the joints on the control mechanism should be inspected to see that there is no lost motion due to slackness.

Pedal Clearance

It is essential that there should be a definite clearance between the pedal and the floorboards when the pedal is fully depressed and that, with the pedal fully depressed, the lever on the gearbox is moved to its full extent, which is governed by a stop inside the box. The pedal must also have at least ¼-in. clearance on the upward stroke in every gear.

Adjustment to Overcome Fierceness

If all gears are unduly fierce, adjustment can be made by slackening back the main-spring adjusting screws, which will reduce the spring loading on all the brake bands. If, however, as is more likely to be the case, only one of the gears is fierce in operation, the following procedure should be adopted :

Remove the top cover, and screw the V-shaped setscrew on the band requiring adjustment one turn out, and lock with the locknut. Select the gear and actuate the pedal a number of times to allow the automatic adjuster to take up to the new setting.

Adjustment to Overcome Slipping

First check that the automatic adjuster is taking up correctly. To do this, remove the top cover of the gearbox and select and engage the gear required. If the wedge-shaped plate on the top of the control mechanism strikes the V-shaped setscrew on the band, and is moved an appreciable amount, then the automatic adjuster should work by actuation of the pedal.

To test this, make a pencil mark on the thimble nut, operate the pedal some two dozen times, and note if it has moved at all. If the adjuster ring is being moved a reasonable amount with each stroke of the pedal, and the mark on the nut does not turn, change the spring and repeat the "pumping action."

The automatic adjuster should work only if the wedge-shaped plate is turned an appreciable amount on striking the setscrews.

If the automatic adjuster is operating correctly and slipping still occurs, the toggle action should be increased according to the following directions :

(1) Make sure that the gear about to be adjusted is disengaged.

(2) Loosen the locknut on the brake-adjuster stop situated on the

brake band, screw in the brake-adjuster stop a half-turn, and lock up. (Screw the adjuster stop upwards for reverse gear.)

(3) Remove one spring eye from the pillar—there is no necessity to remove the spring completely.

(4) Slacken back the tapped automatic adjuster nut by half a turn.

(5) Replace the spring on the spring pillar.

(6) Select the gear which has just been adjusted.

(7) Pump up until automatic adjuster nut stops turning.

Top-gear Adjustment

Slacken back the top-gear automatic adjuster nut and pump up until the point is reached where the travel of the mechanism suddenly decreases. Mark the adjuster nut, and continue to pump up.

The adjuster nut should cease to move after it has completed a quarter of a turn from the marked position. This is the correct setting. Check this adjustment before altering the adjuster nut.

To Decrease Toggle Action

Should it be necessary to decrease the toggle action, proceed as follows :

(1) Loosen the locknut on the brake-adjuster stop and screw out the adjuster stop half a turn. (Screw adjustment stop downwards for reverse gear.)

(2) Pump up until the automatic adjuster nut stops turning.

Another possible cause of slip which should be investigated is that of the pedal fouling the floorboard on the return ; if this should occur, the length of rod must be adjusted so that there is at least $\frac{1}{4}$-in. free movement when the gear is fully engaged.

Dismantling Gearbox

The dismantling of the gearbox may be dealt with in two sections : (1) to remove the running gear, and (2) to remove the gear casing and dismantle the brake gear.

To Remove Running Gear

Select and engage top gear. This will take some of the load off the main spring and make it easier to detach and remove the spring cap. Remove the drain plug and drain out the oil. Remove the selector cover from the side of the box, and also the top cover.

Remove the actuating spring cap (there is no need to undo the adjusting screw to reduce the tension, so that adjustment of this when reassembling will be correct), and withdraw the actuating spring, spring guides, and buckets complete. Take out the speedometer pinion and casing ; and though it is not absolutely necessary to remove the coupling flange from the end of the output shaft, it will be found that its removal

will permit of the output shaft being used as a drift for freeing the input shaft prior to its removal.

Now remove the top-gear automatic adjuster spring and the top-gear automatic adjuster nut. This has the effect of releasing the operating pin for top gear. Remove the nuts from the rear end casing and break the joint by tapping gently. Now remove the nuts from the front-cover flange, and break the joint by tapping the rear of the output shaft towards the front.

The whole of the running gear complete can now be removed through the front of the casing, or it can be taken out in two sections, removing first the input shaft complete with bearing and top-speed inner cone, and then removing the rear portion of the running gear, together with the output shaft, also through the rear of the casing. This latter method has the advantage that the weight of the component to be handled at one time is considerably reduced.

There is one point that must be watched when removing the running gear; that is, that the operating pin for the top-gear operation which is left hanging in the top-speed inner cone does not foul on the casing when removing the gear through the end opening.

Having withdrawn the running gear, stand it vertically on end so that the various parts may be lifted in their correct order, and so facilitate re-erection.

To Remove Bottom Cover and dismantle Brake Gear

Remove the setscrew securing the top-gear hooks.

When replacing, do not forget the distance washer between the hooks.

To Dismantle Brake Bands

Remove the automatic adjuster spring, the adjuster nut, the adjuster ring, and the adjuster table. Lift out the thrust-pad and strut as one unit.

Turn the gearbox on its side and remove the nuts securing the bottom cover and lift the case away complete with the brake gear. Press down on top of the brake band, and disengage the two hooks which take in the lug on the brake band, then pull the brake band to one side. Take out the split-pin and joint pin on the brake strut and centralisers, *taking great care not to lose the centraliser guide springs.*

To Reline Brakes

The brake is relined in the normal way, and it is important that each brake should be carefully bedded-in before replacement in the box. The brake should be assembled complete with the fittings. See that the inner band is in its correct position.

(1) See that the bands are approximately circular. The bands can be tested for truth on a jig.

(2) Tighten up the band on the jig to locate any high spots, which should be removed.

(3) Test on the jig for truth, and continue until there is an accurate bearing surface all round.

Reassembling Gearbox

When erecting the gearbox the process for removing the brake bands is reversed. Care must be taken to see that the centraliser springs are not omitted.

Assemble the reverse brake band first, as follows: Place the band in position and enter the offside centraliser spring and pin. Engage the brake hooks. Enter nearside centraliser spring and pin. The reverse band will now be in its running position. Connect up the pin, with the internal brake-band link in the vertical position.

Clean the faces and apply jointing to the bottom cover; replace the case, securing with nuts. In replacing the case, care must be taken not to damage the small hairpin spring on the struts, otherwise difficulty in selection will be experienced.

Assemble thrust-pad, automatic adjuster table, ring, and nut. On completing the assembly of the brake bands see that the top-gear pull-rod is in its position. Do not forget to replace the busbar. Secure the top-gear hooks with the setscrew and distance-piece. It is important that working faces of brake-band centralisers must be in contact with stop.

Before inserting the running gear, take great care that the brake liners are well in line. A block of wood turned to the appropriate size and pushed through first will assist in this way.

Put jointing on the front cover. Insert the running gear from the front of the box, taking great care that the assembly is not broken; *on no account must it be pulled through from the rear end.* Care should be taken to see that the cup and pull-rod for the fourth gear are in position, otherwise it will jam the running gear.

Secure the front end cover with nuts and spring washers. Hook the top-gear strut into the cup at the bottom of the pull-rod, and replace the top-gear strut, table, and nut. Put jointing on the rear end cover. Fit the rear end cover and rear end coupling.

Replace the actuation-spring bucket, taking care that the small bucket is correctly assembled; next replace the two members in the actuating spring, taking care that the bottom pivot is in the centre of the bucket. Replace the spring cover and screw down the spring until the locking wire can be placed in the same hole from which it was taken when dismantling the box. Replace the adjusting-screw cover, the cam gear on the side of the box, and then the speedometer drive.

Pump up by means of a bar attached to the gear-engaging lever, and adjust the toggle action.

THE LEYLAND PETROL ENGINES, CLUTCH, AND GEARBOX

By GEORGE T. CLARKE

ENGINES AS FITTED TO THE TITAN AND BEAVER CHASSIS

	Six-cylinder		*Four-cylinder*	
Bore . . .	$4\frac{1}{2}$ in.	$4\frac{9}{16}$ in.	$4\frac{1}{2}$ in.	$4\frac{9}{16}$ in.
Stroke . . .	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.
R.A.C. rating .	43·5 h.p.	50 h.p.	28·9 h.p.	33·3 h.p.
B.H.P. at 1,000 r.p.m.	60	69	43	49

sump on the four- and six-cylinder engines have a capacity of $2\frac{3}{4}$ and $3\frac{1}{2}$ gall. respectively. A large box-form strainer is housed in the sump, along with an efficient oil cooler and filter under the front of the sump. The gear-type pump draws the lubricating oil from inside the strainer and forces it, by way of a pressure relief valve and the filter, to the main system. A secondary pump delivers oil by way of a cored oilway in the crankcase and the timing case, to the timing gear and camshaft trough, whence it is thrown by the camshaft on to the timing gear. Excess oil from the trough is returned to the sump down a cored oilway in the cylinder head and block. The oil circulation is shown diagrammatically in Fig. 1.

The suction oil pipe and the main delivery pipe are of drawn steel tube, secured on studs in the crankcase. The branch pipes to the main bearings are of copper, and are connected by means of unions to the main delivery pipe and main-bearing caps.

Removing and dismantling Oil Pump

The pump is removed by dropping the sump and disconnecting the suction and delivery pipes. After removing the wire, take off the three nuts securing the pump and then remove. Dismantling the pump is straightforward, but to withdraw the spindle, take off the nut and very gently drift the spindle through the ball race. When reassembling see that the chip guard for the spindle bearing and the two paper washers between the baseplates are replaced or renewed. When replacing the pump, see there is a slight backlash in the skew gears.

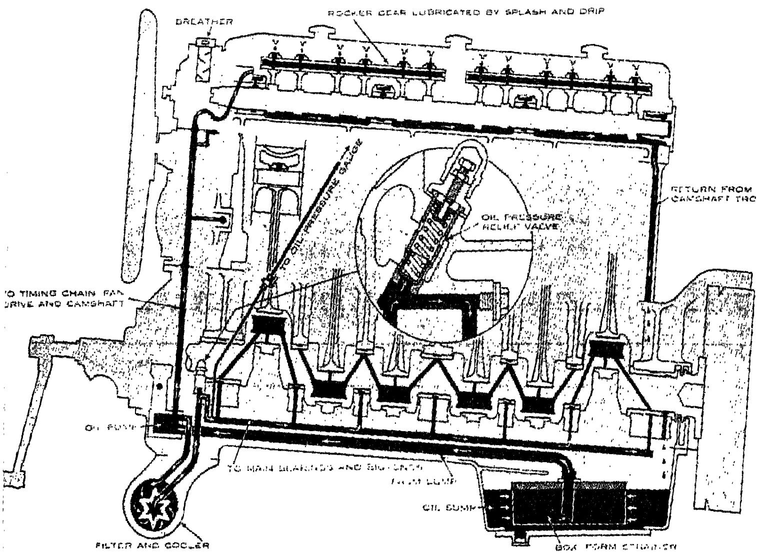


Fig. 1.—LEYLAND ENGINE OIL-CIRCULATION DIAGRAM

Oil Filter and Cooler

The star-sectioned gauze filter element (Fig. 1) is housed in a finned light alloy casing. The oil enters the casing outside the element and is forced through the gauze into the central passage, whence it passes to the main delivery pipe. A by-pass valve is provided in the end cover to prevent shortage of oil due to a choked or neglected element. The element should be removed and cleaned at least every five thousand miles. It is easily removed by taking off the end cover after draining the casing through plug. The element should be well washed in paraffin and allowed to drain before replacement.

Oil-pressure Relief Valve

The oil-pressure relief valve is of the spring-loaded type, as shown in Fig. 1, housed in the crankcase oilway, between the filter and the main delivery pipe. The adjusting screw is situated below the magneto platform, and enclosed by a screw-on cover. The valve should be adjusted to show 45 lb. on the pressure gauge with the engine warm and running at about 1,000 r.p.m.

An electrical oil-pressure indicator is also fitted on passenger chassis. The main object of this indicator is to draw the attention of the driver to oil-pressure failure from any cause. A blue light appears on the pressure falling below 20 lb. The indicator is in the ignition circuit, and comes on when the engine is switched " on " and goes out on the engine starting up.

If, when the engine is ticking over, the pressure falls below 20 lb., the blue light will appear, but immediately goes out on speeding up the engine.

Valve Timing and Tappet Clearances

The valve timing and tappet clearances are: Inlet opens 2° after top dead centre; inlet closes 42° after bottom dead centre; exhaust opens 48° before bottom dead centre; exhaust closes 4° after top dead centre. Measurements on flywheel rim: 2° is ·32 in., 4° is ·64 in., 42° is 6·74 in., and 48° is equivalent to 7·72 in. Tappet clearance (hot): inlet ·008 in.; exhaust ·010 in.

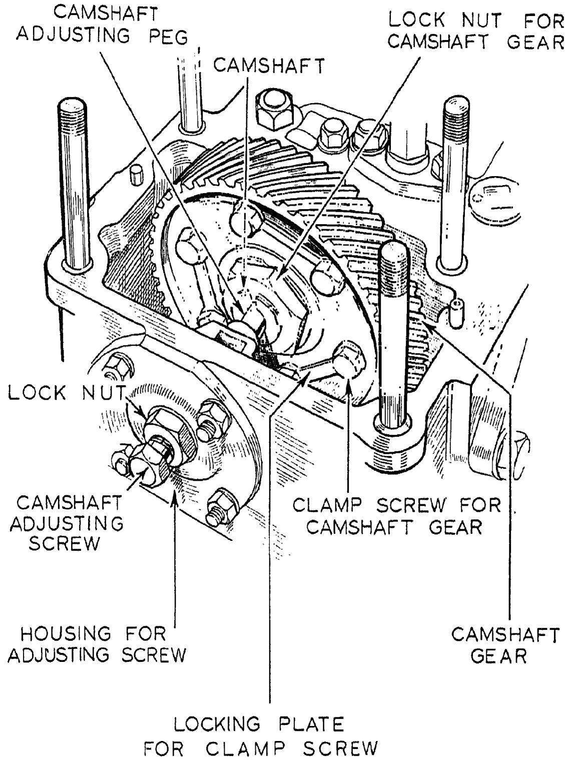


Fig. 2.—CAMSHAFT TIMING-WHEEL ARRANGEMENT

Valves and Seats

The cylinder head is a single casting, with stellite-faced exhaust seat, and medium-carbon-steel inlet-valve seats screwed into the cylinder head. The exhaust valves are of different material from the inlet valves, but can easily be distinguished by their different form. Double concentric valve springs are used, and are located by the usual conical cotters. There should always be $\frac{1}{16}$-in. clearance between two halves of the cotters. A baffle fitted for each pair of valves, to prevent carboned oil getting on the valve stems and to prevent sticking; the baffles also restrict the quantity of oil thrown on the stems by the camshaft. The rocker levers are bushed and carried on hollow shafts, the ends of the shafts being sealed with welch washers. Each of the two shafts is carried on three supporting brackets, which also locate the shafts endwise. The rockers are

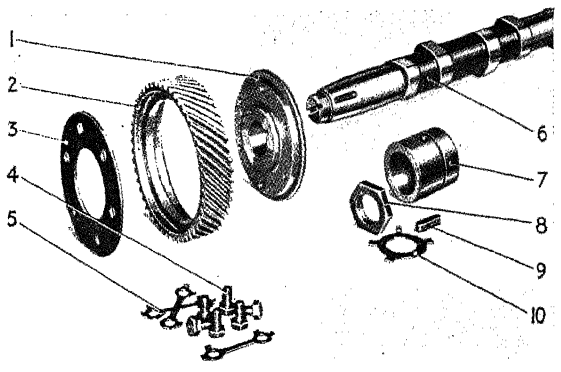


Fig. 3.—CAMSHAFT ASSEMBLY

(1) Hub for camshaft drive gear. (2) Camshaft gear. (3) Clamping plate for camshaft gear. (4) Clamp-screws. (5) Locking plate for clamp-screw. (6) Camshaft. (7) Camshaft front bearing. (8) Locking nut for camshaft gear. (9) Key for camshaft-gear hub. (10) Locking washer for nut.

located by means of springs. Felt pads are fitted inside the adjusting screws and should not be removed, excepting on renewal.

Overhead Camshaft

The overhead camshaft is carried in four phosphor-bronze bearings, the two intermediate bearings being of the split type. The rear bearing is a flanged bush secured on the back of the head, whilst the other bearings are held by means of locating screws in the housings. Oil is supplied to the front bush from the oil pump and then flows into a trough, so arranged that each cam dips into an oil-bath, the excess oil returning to the sump through an oilway at the rear of the head. Part of the oil thrown up by the cams accumulates on the projections in the valve-gear cover and drops into pockets provided on each rocker and camshaft bearing. Thrust due to a backfire is taken on a hardened-steel peg, seen in Fig. 2, which bears on the hardened end of the adjusting screw. The gearwheel is locked on the hub by a clamping plate. The hub is keyed on the taper end of the camshaft. This arrangement (*see* Fig. 3) permits the timing of the camshaft after the cylinder head has been replaced, by slackening off the set-screws and turning the camshaft ; it also provides an infinitely fine adjustment when fitting a new wheel.

The camshaft can be removed without lifting the cylinder head, after removing the radiator. The mark on the chain sprocket cannot be seen when the cylinder head is down, therefore the position of the timing mark on the back of the camshaft wheel should be checked before removing the wheel. When No. 1 piston is on top dead centre of the firing stroke, the line on the timing wheel should be parallel with the cylinder head.

Without going through the whole process of removing the shaft, the shaft can be tapped back through the timing gear with a brass drift until the wheel is released from the taper and lifted out. There is sufficient clearance to allow the camshaft to go back to clear the wheel. The shaft can now be drawn through, care being taken to collect the halves of the bearings as they leave the housings.

Camshaft Bearings

The front and rear bearings should be a tight push-fit in the housings, and should have a clearance of ·005 in. on the shaft. The intermediate bearings should have a slightly greater clearance, of ·007 in. on the shaft. In replacing there should be a clearance of about $\frac{1}{16}$ in. between the face of the front bearing and the camshaft timing wheel. This can be checked by removing the locating setscrew from the front housing and pushing the bearing forward. The clearance can then be checked by the position of the hole for the locating screw. The timing mark on the wheel should be in the same position as when removed, otherwise the camshaft will have to be retimed.

Removal of Cylinder Head

Fig. 4 gives the order of tightening the cylinder-head nuts. The makers, however, have provided a means of assisting in the head removal. Two special lifting nuts are provided to prevent damage to the head and gasket. A shoulder, formed on the base of each nut, is recessed in a plate, which is attached to the cylinder head by two studs. Unscrewing the nuts will lift the head clear of the gasket. Unscrew the nuts until they are clear of the studs and then attach the lifting sling. If the head removal proves difficult, a further lift can be obtained by screwing two long $\frac{1}{2}$-in. B.S.F. bolts into the lifting nuts.

Dealing with Valve Seats

The exhaust-valve seats cannot be faced by ordinary grinding or with a valve-seat cutter. If they are pitted, a special carborundum tool must be used with a grinding face of 30°, or 60° included angle. The tool is run at high speed, and vibrates on a pilot fitted into the valve guide. The inlet seat can be trued up with a good-class cutter. The exhaust seats can be removed with a tool that fits into the splines inside the seat, but with the inlet seat the splines have been turned out, and the seat will have to be carefully cut out with the aid of a sharp chisel, preferably having a narrow edge. New seats can be screwed in, and it is not absolutely necessary to remove the splines from the interiors of the inlets ; but if this

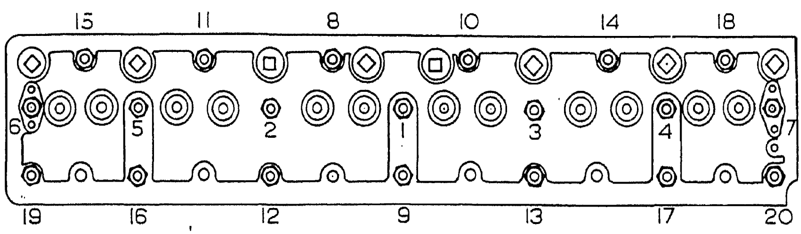


Fig. 4.—ORDER OF TIGHTENING CYLINDER-HEAD NUTS

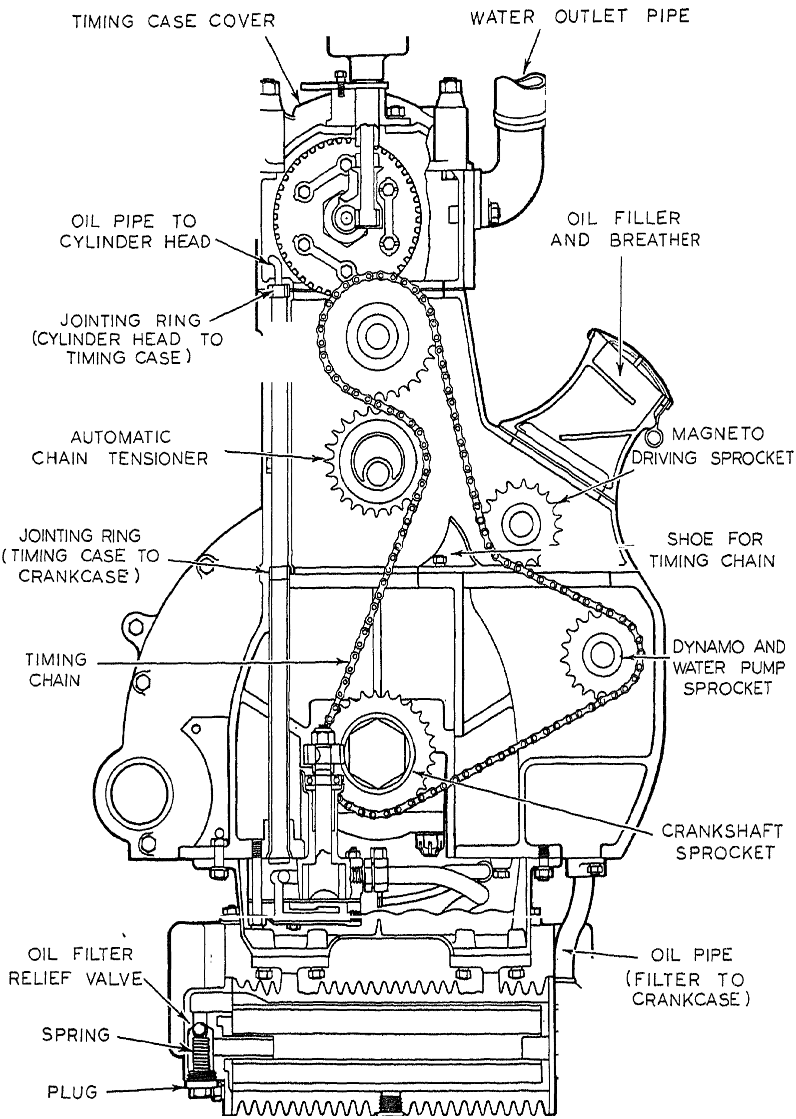


Fig. 5.—Cross-section through engine (six-cylinder)

is done, a cutter should be used having a stem to locate in the valve guide.

Valve guides are renewed from the outside, and the stems of the valves should have a clearance of ·010 in. to avoid sticking.

Replacing Head

When replacing the head, the camshaft is retimed by turning the engine until No. 1 piston is on top dead centre of the firing stroke. A timing plunger, which locates with a hole provided in the flywheel, can be used on the six-cylinder model to find this position, and the line on the rear face of the chain wheel is level with the top of the timing case. Check that the magneto is firing on No. 1 cylinder, as it is possible for it to be 180° out with the camshaft timing, but not possible with coil ignition. Lower the head on the lifting nuts, when the timing wheels will be on the point of meshing. Turn the camshaft until the line mark on the camshaft gear is level with the top of the cylinder head and screw down the lifting nuts evenly, testing at intervals to see if the wheels are meshing correctly. Care should be taken at the moments of meshing that a tooth on the camshaft gear does not ride on the sliding part of a tooth of the split timing gear. To avoid this, place a small bar between the sprocket and the split timing gear and press the sliding part of the gear back, and then engage the teeth. All helical gears are a little difficult in this direction, as they present a large surface of teeth.

An alternative method of timing the camshaft is to set No. 1 piston on top dead centre as before, lower the head and mesh the gears, and time as previously stated. Before fitting the rocker gear, check that there is ample backlash in the gears when the head is tightened down and the split timing wheel is pressed back. The gears are cut specially deep to prevent bottoming; if they appear tight a new gasket should be fitted. It is wise to use a new gasket in every instance.

Replacing Timing Chain

The camshaft and auxiliaries are driven by a duplex roller chain, the drive being taken by sprocket shafts in the crank and timing cases. Chain stretch is taken up by an automatic tensioner; also, a shoe fitted under the magneto sprocket precludes slip that may be due to slackness. The tensioner is at its minimum when the chain is new, and, when the tensioner is at its maximum, it is a sign that the engine requires a new chain. Fig. 5 shows the layout of the chain.

The new chain for the six-cylinder measures 4 ft. $9\frac{1}{2}$ in., and for the four-cylinder engine 4 ft. $10\frac{1}{2}$ in. If the worn chain measures, when stretched right out on a face-plate, 4 ft. $10\frac{3}{8}$ in. for the six-cylinder and 4 ft. $11\frac{3}{8}$ in. for the four-cylinder engine, a new chain should be fitted without delay. To fit a new chain, the cylinder head must be removed and a link from the old chain removed by a rivet extractor. The new chain

should be connected to the end of the old chain by means of a split link, and then engine cranked, at the same time feeding in the new chain. Keep the tension on the right-hand side by holding the chain in the sprocket, release the tensioner, detach the old chain and rivet up the new chain. Be sure to check over the valve timing and adjust the tensioner.

In the case of a broken chain, when the crankcase has to be removed to extract the broken pieces of chain it is as well to thoroughly examine the pump connections. Remove the timing case, and attach long pieces of wire to the ends of the new chain and feed the ends of the wire up the timing case.

Special care must be taken to see that the rubber ring round the ferrule connecting the vertical cored oilways in the timing case is replaced. It should also be noted that this rubber ring is thinner than the one fitted between the cylinder head and the timing case.

Cylinders

At overhaul, the cylinders should be measured and new liners fitted if the wear at the top of the bore exceeds ·015–·020 in. Some of the earlier engines are not fitted with liners, therefore the monobloc should be bored out to take liners supplied by the makers, or the block sent to one of the makers' service stations.

Pistons

The pistons are oval and taper ground, and have a clearance of ·004 in. on the skirt and ·010 in. on the ring lands. The pistons are fitted with three compression rings and one scraper ring. New rings should have ·001–·002-in. side play. The gap for the top ring should be ·010 in. and ·008 in. for the lower rings. The side play in the rings must not exceed ·006 in., and the gap ·020 in. after use ; if so, they must be renewed.

Connecting Rods

The connecting rod and piston cannot be removed together from below. The Babbit is run direct into the connecting-rod big end, whilst the small ends are bushed with phosphor-bronze with fully floating gudgeon pins secured by circlips. The gudgeon pins should be a tight push-fit in the pistons and an easy fit in the small-end bushes. The pistons must not be reamed to take the gudgeon pin, as the reamer cannot produce a hole of sufficient accuracy and surface. To facilitate fitting the pins the pistons should be immersed in boiling water.

The big ends are bored to size, but shims are fitted ·002 in. thick for taking up the bearings during the life of the engine. Neither rod nor cap should be filed to take up excessive play. Connecting rods with under-sized bearings can be obtained from the makers. Scraped bearings should show at least 75 per cent. bed, with ·001–·002-in. clearance on the crankpin with an end play of ·002–·003 in.

Crankshaft

All crankshaft journals are $2\frac{3}{4}$-in. diameter, and the crankpins $2\frac{1}{4}$-in. diameter. The crankshaft is drilled for lubrication purposes, the blind ends being made oil-tight by means of cup-washers pulled up on copper and asbestos washers. It is essential that these washers are inspected for tightness when the sump has, for any purpose, been removed. In the event of loss of oil pressure, after checking that neither the oil gauge nor the connecting pipe is at fault, it is advisable to check these washers, hence the precaution when the sump is down.

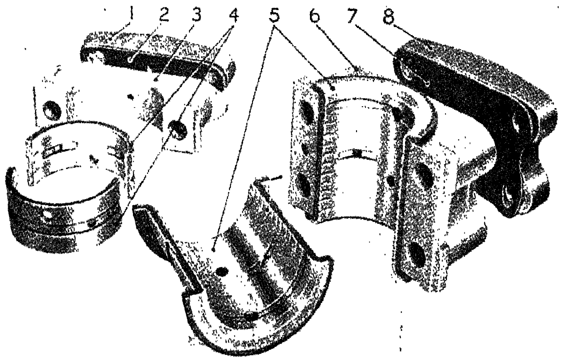


Fig. 6.—Main bearings

(1) Main bearing cap (intermediate). (2) Joint for bearing cap (intermediate). (3) Main-bearing cap plate (intermediate). (4) Main bearing (intermediate). (5) Main bearing (rear). (6) Main-bearing cap plate (rear). (7) Joint for main-bearing cap (rear). (8) Main-bearing cap (rear).

Main Bearings

The bearings are of the bronze shell type and Babbit-lined, and the rear, centre, and front bearings are located by dowels engaging in holes in the shells. Each bearing has an oil groove in the back of the shell communicating with the main oil system. To ensure a constant supply holes are drilled in the grooves, and small grooves formed on the face of the bearing, as shown in Fig. 6. All main bearings are index marked; therefore, when correctly assembled, all markings coincide. The crankshaft should have an end play of ·004 in. on the rear bearing, but an end clearance of $\frac{1}{32}$ in. on all other bearings. After scraping, the shells should have a clearance of ·002 in. on the crankshaft. Fig. 7 shows the rear main bearing.

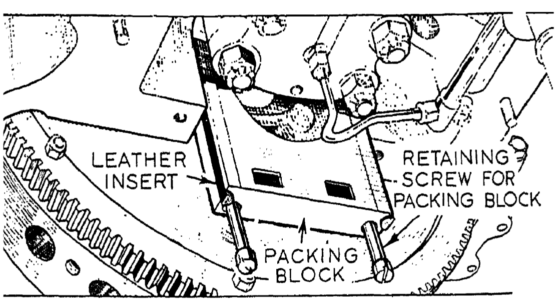


Fig. 7.—Rear main bearing

Renewing Water-pump Packing

The water-pump construction is shown in Fig. 8. It will be noted

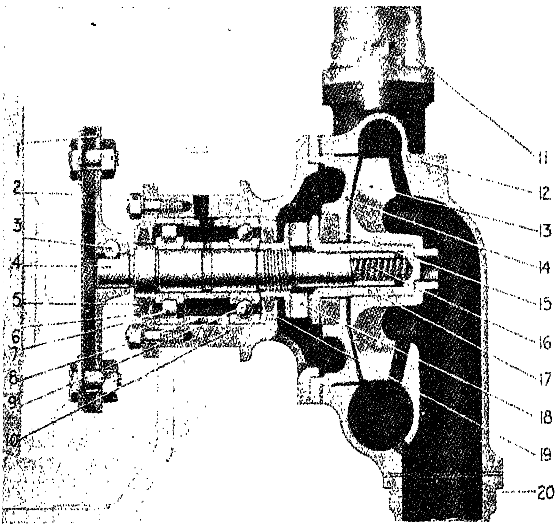


Fig. 8.—SECTION THROUGH WATER PUMP

(1) Coupling on driving shaft. (2) Flexible driving disc for coupling. (3) Cotter for coupling. (4) Water-pump driving shaft. (5) Felt washer for bearing housing. (6) Bearing housing (front). (7) Roller bearing for driving shaft. (8) Distance piece between bearings. (9) Ball bearing for driving shaft. (10) Bearing housing. (11) Flexible water outlet pipe. (12) Water-pump casing. (13) Impeller. (14) Water-pump cover. (15) Carbon packing. (16) Spring for driving sleeve. (17) Driving sleeve for impeller. (18) Driving collar on shaft. (19) Bearing cover (rear). (20) Bottom water inlet elbow.

that the ball races are completely isolated from the water. The carbon packing should require no attention for very long periods, but if found to have worn to a depth of ½ in. it should be replaced. Great care is needed when removing the old carbon and fitting a new one to ensure a watertight seat being made. The gland housing should be heated in oil until the old carbon can be shaken out, and not prised out and damaging the housing. While the housing is still hot, press in the new carbon, making quite sure that it has been pressed well home. The flanged seating should be lapped together to obtain a watertight seating. The whole should be well washed in paraffin and then clean petrol, as the smallest piece of grit will ruin the seating you have created.

CLUTCH AS FITTED TO TITAN AND BEAVER CHASSIS

The single-plate clutch used on the Titan and Beaver chassis is completely shown in Fig. 9. The spigot race is packed with H.M.P. grease, and needs no attention excepting at overhaul. The withdrawal race should be lubricated weekly with gear oil by means of the nipple provided, but should not be over-lubricated.

There should always be 1 in. of free travel on the clutch pedal, and a large adjusting nut at the pedal is provided for this purpose. When this adjustment is all taken up, the withdrawal fingers require attention. Slacken all three locknuts on the adjusting screws, and adjust the screws until the withdrawal collar can be pushed forward far enough to insert

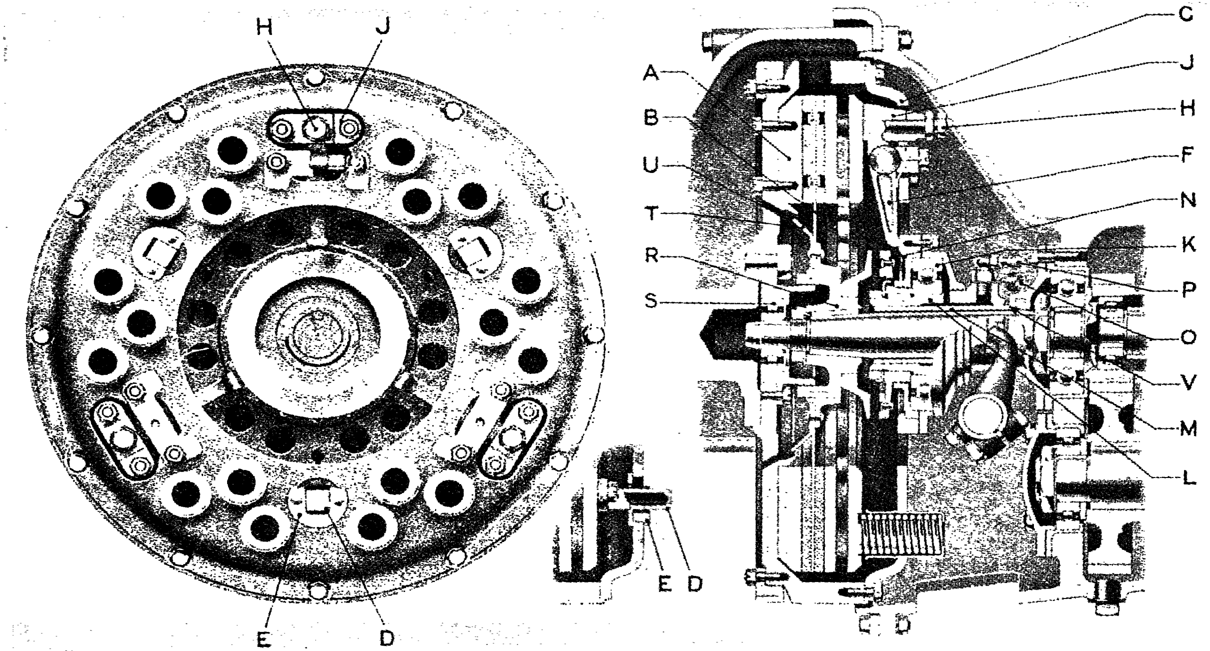


Fig. 9.—ARRANGEMENT OF CLUTCH AS FITTED TO TITAN AND BEAVER CHASSIS

(A) Flywheel insert. (B) Clutch plate. (C) Clutch cover. (D) Square driving pegs. (E) Pressure-plate bushes. (F) Withdrawal fingers. (H) Hardened adjusting screws. (J) Lifting brackets. (K) Thrust-race. (L) Thrust-race sleeve. (M) Thrust-race sleeve extension. (N) Fixed member of clutch stop. (O) Withdrawal-sleeve spring. (P) Flexible lubrication pipe. (R) Splined hub keyed on clutch shaft. (S) Clutch-shaft spigot roller bearing. (T) Oil-throwing finger. (U) Holes in flywheel to exude excess lubricant. (V) Point of insertion of feeler gauge.

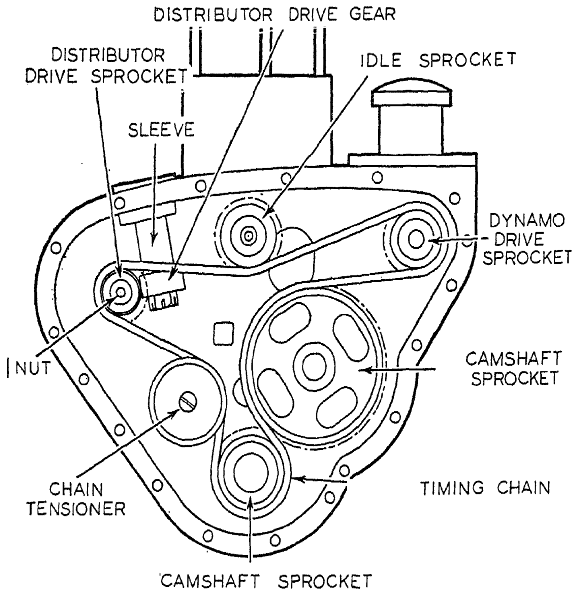


Fig. 10.—END VIEW OF LIGHT SIX PETROL ENGINE
Showing layout of timing chain.

a $\frac{1}{8}$-in. gauge at the point (*V*). Insert the gauge and adjust each finger until it bears lightly on the withdrawal collar, and then tighten the locknuts solid. The three fingers must bear equally on the collar. Readjust the nut (*W*). This adjustment can be carried out until the liners are only $\frac{1}{16}$ in. thick, as indicated by the driving pegs (*D*), which will then project $\frac{1}{4}$ in. through their bushes.

Relining Clutch

When relining, the plate should be true to at least $\frac{1}{32}$ in. after relining. Only tubular brass rivets should be used, and the liners should be obtained from the makers. A maximum of $\frac{1}{32}$ in. can be removed from the flywheel insert and the pressure-plate if scored. To remove the splined hub (*R*), unscrew the locking nut; the clutch shaft can be prevented from rotating by locking the constant-mesh gears with a bar of soft metal between the teeth. When fitting a new hub, test that it is free on the splines in the clutch plate. It can be eased with grinding compound, and should be tried out on all splines in case of another disassembling, when the operator may not replace the plate on the same splines and perhaps cause sticking.

LIGHT SIX PETROL ENGINE AS FITTED TO LYNX CHASSIS

The difference in this engine to those previously described is that the valves are "push-rod" operated from the camshaft in the crankcase, also other slight alterations in design that should need no special mention. However, where important variations occur, and where it is necessary to observe specific rules in the maintenance and overhaul, detail of observance will be described.

The bore of this engine is $3\frac{1}{2}$ in., and the stroke is 5 in. The inlet

valve opens at top dead centre and closes at 52° after bottom dead centre; the exhaust opens at 44° before bottom dead centre and closes at 8° after top dead centre. There is no secondary pump attached, but in the main the system of lubrication is through a drilled crankshaft. The oil pressure should be 40 lb. with the engine hot and at normal road speeds.

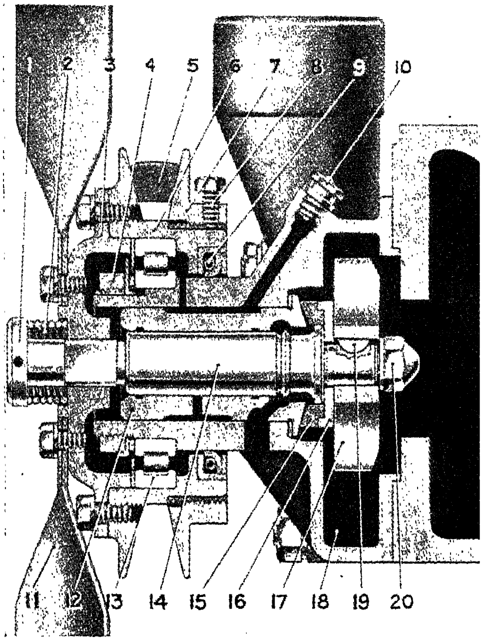


Fig. 11.—FAN AND WATER PUMP (LIGHT SIX ENGINE)
(1) Collar for pump spindle. (2) Spring for pump spindle. (3) Cover for bearing housing. (4) Locknut for roller bearing. (5) Driving belt. (6) Driving flange (large). (7) Driving flange (small). (8) Locking screw for driving flange. (9) Oil seal. (10) Nipple for bearing. (11) Fan. (12) Phosphor-bronze bush. (13) Roller bearing. (14) Pump spindle. (15) Carbon gland. (16) Housing for carbon. (17) Impeller. (18) Water-pump casing. (19) Key for impeller. (20) Nut for impeller.

Timing Chain

The layout of the timing chain is shown in Fig. 10, and is tensioned in the manner already described. The chain consists of 126 pitches of $\frac{3}{8}$-in. pitch, and when new has a total length of $47\frac{1}{4}$ in., and should be discarded if the length exceeds $47\frac{5}{8}$ in. This engine is fitted with battery ignition, and the distributor drive is shown in Fig. 10.

Damper

A friction-type damper is fitted on the front end of the crankcase, outside the engine. The linings should be washed in petrol if slipping occurs, and the rubber ring to exclude dirt should be either in very good condition or be renewed if in doubt.

Connecting Rods

The connecting rods and pistons can be withdrawn if the caps are first removed from the rods, when they can be drawn up through the bore. The crankshaft therefore need not be removed. The connecting rods are drilled and pipes fitted to lubricate the small-end bushes. The order of cylinder-head nut tightening should follow the usual practice.

Water Pump

The water pump (Fig. 11) is fitted with a carbon gland, but of a different pattern from that previously described; and the same precaution should be taken in the renewal of the carbon, specially noting the cleanliness of the operation.

CLUTCH AS FITTED TO LYNX CHASSIS

The clutch on this model is simple in design. The clutch pedal should always have $\frac{3}{4}$-in. free movement, obtained by adjusting the nut under the pedal lever.

GEARBOX ON THE BEAVER AND TITAN CHASSIS

Removal of the box from the chassis follows the usual methods adopted in workshops.

In the process of dismantling it will be necessary to draw the mainshaft back, together with the rear-bearing housing, far enough to remove the spigot bearing, which is a tapping fit on the shaft. Withdraw the sliding dog, spring open and remove the circlip and draw off the retaining plate, then draw the shaft farther back and remove the gears through the inspection door. When needle bearings are fitted, the retaining plate is secured by a locking plate.

To remove the mainshaft, draw the shaft back and remove the sliding dog as already outlined; then lift the small spring on the locking plate, extract the locking peg, and turn the locking plate until it can be drawn over the splines on the shaft; the retaining plate is then withdrawn. Draw the shaft back as far as possible, and drive it through the gear by using a soft drive. The shaft should be held horizontal, and the gear should be held with one hand to prevent the rollers dropping out when it is withdrawn.

When rebushing the shaft for third gear, note that the bush is pressed on the shaft, and a running clearance of not less than ·002 in. must be allowed between the bush and the wheel. The end play is ·003–·005 in., and circlips are available in three thicknesses to obtain this clearance. Use rubber bands to retain the needles in position whilst feeding into the gear. A clearance of at least $\frac{1}{16}$ in. must be allowed between the coupling flange and the distance-collar on the third-motion shaft, thus ensuring that the flange is fitted hard up on the taper.

The layshaft is carried on roller bearings, end thrust being taken by a large thrust-race. The first gear is formed integral with the shaft, the other gears being pressed on and the drive taken by a key. When replacing the layshaft, fit the shaft in the front-end bearing, replace the rear housing and outer race of the rear roller bearing, then place the thrust-race on the shaft, and pull up with the nut and lock the nut with the tab washer. There is an oil seal at the front end of the gearbox, and this should be examined for loss of oil, and the breather should be cleaned.

LEYLAND OIL-ENGINES

LEYLAND oil-engines are made in two distinct types : (1) employing a direct-injection combustion chamber, and (2) employing a turbulent ante-chamber.

Direct-injection Engines

The first type of chamber, employed on four- and six-cylinder engines, consists of a simple open cup formed in the head of the piston. The cylinder head is flat and carries the nozzle and its holder so mounted that the fuel is directed obliquely downwards into the cup. The cup is offset in the piston, so that it comes directly under the nozzle. The final mixing of the fuel and air charge is ensured by giving the latter a steady swirling motion, and to ensure a sufficiently rapid movement the inlet valves are screened on one side so as to direct the air during its entry into the cylinder. The compression ratio is about $15\frac{1}{2}$ to 1.

Operation

In this type of engine an air charge only is drawn in during the induction stroke, and is then compressed to about 450 lb. per square inch. By this means the temperature is increased to about 1,000° F., which is sufficiently high to ignite the fuel when it is sprayed into the cylinder towards the end of the compression stroke. The fuel ignites very rapidly, so that the timing of the injection is just as important as the timing of the spark in a petrol engine. Too early injection gives a knock at low speeds, and rough and noisy running at high speeds. Too late injection causes loss of power. On the other hand, it is not necessary to vary the timing while running, and no control is fitted.

The quantity of fuel delivered to the engine at each injection is varied according to the load requirements, and the injection period, therefore, ranges between 5° duration at no load and 25° at full load. The fuel-nozzle valve is set to lift at 2,350 lb. per square inch, the actual injection pressure rising somewhat above this figure at high speed.

The quantity of fuel delivered at each injection is controlled by the driver by means of the usual foot throttle. This is interconnected with the governor in such a way that the governor controls the engine speed while idling and can cut in to prevent a certain maximum speed being exceeded.

The direct-injection engine's data are as follows :

	Six-cylinder	*Four-cylinder*
Bore	$4\frac{1}{2}$ in. (114·3 mm.)	$4\frac{1}{2}$ in. (114·3 mm.)
Stroke	$5\frac{1}{2}$ in. (139·7 mm.)	$5\frac{1}{2}$ in. (139·7 mm.)
Capacity	524·7 cu. in. (8,598 c.c.)	349·8 cu. in. (5,732 c.c.)
R.A.C. rating	48·6	32·4
B.h.p. at 1,000 r.p.m.	58	38
Fuel consumption (average)	0·37 pint per b.h.p. hr.	0·37 pint per b.h.p. hr.

Turbulent Ante-chamber Engine

The Leyland Light Six oil-engine is of the ante-chamber type, a spherical ante-chamber being formed half in the cylinder head and half in the block. In this type of engine the air charge is compressed to about 450 lb. per square inch, the temperature being 950° F.

In order to obtain the high compression ratio the piston is brought close to the cylinder head, and it is necessary to see that it does not project more than $\frac{1}{64}$ in. above the block when assembling. For the same reason the valves must be correctly timed or they may be struck by the pistons.

The engine data are as follows :

No. of cylinders : 6
Bore : $3\frac{1}{2}$ in. (88·9 mm.)
Stroke : 5 in. (127 mm.)
Capacity : 288·8 cu. in. (4,371 c.c.)
R.A.C. rating : 29·4
B.h.p. at 1,000 r.p.m. : 34
Fuel consumption (average) : 0·41 pint per b.h.p. hr.
Firing order : 1 5 3 6 2 4

DIRECT-INJECTION ENGINES

Many details on these engines are similar to the Leyland petrol engine dealt with on pp. 513–522. There is no necessity, therefore, to repeat

TABLE SHOWING DIMENSIONS ON FLYWHEEL RIM EQUIVALENT TO ENGINE DEGREES

Engine Type	*Four-cylinder*							
	E.45	*E*.53	*E*.54 *Goods*	*E*.54 *Pass.*	*E*.61	*E*.65	*E*.101	*E*.118
8°	in. 1·3	in. 1·3	in. 1·3	in. 1·5	in. 1·5	in. 1·5	in. 1·5	
44°	7·1	7·1	7·1	8·4	8·4	8·4	8·4	8·4

Engine Type	*Six-cylinder*								
	E.28 *Goods*	*E*.28 *Pass.*	*E*.37	*E*.38 *Goods*	*E*.38 *Pass.*	*E*.39	*E*.1(	*E*.103	*E*.120
8°	in. 1·3	in. 1·2	in. 1·3	in. 1·3	in. 1·2	in. 1·3	in. 1·3	in. 1·3	in. 1·3
44°	7·1	6·5	7·1	7·1	6·5	7·1	7·1	7·1	7·1

instructions already given; only the features which differ need be described.

Valve Timing and Adjustment

The valve timing is as follows:

Inlet opens
8° before T.D.C.
Inlet closes
44° after B.D.C.
Exhaust opens
44° before B.D.C.
Exhaust closes
8° after T.D.C.

The table on page 528 gives the dimensions on the flywheel equivalent to engine degrees.

The correct clearances are ·008-in. inlet and ·010-in. exhaust with a hot engine.

When adjusting valve clearances, it is necessary to check that the rockers are on the back of the cams, and the engine should be turned to bring each rocker in turn to this position. To turn the engine the decompressor must be operated, and care must be taken to see that it is out of action when setting the valve clearance. The decompressor (*see D*, Fig. 1) consists simply of a shaft having eccentrics formed to operate on top of each exhaust-valve rocker. The shaft is carried in five bearings, secured to the cylinder-head studs. It is operated through a short link by a handle at the front of

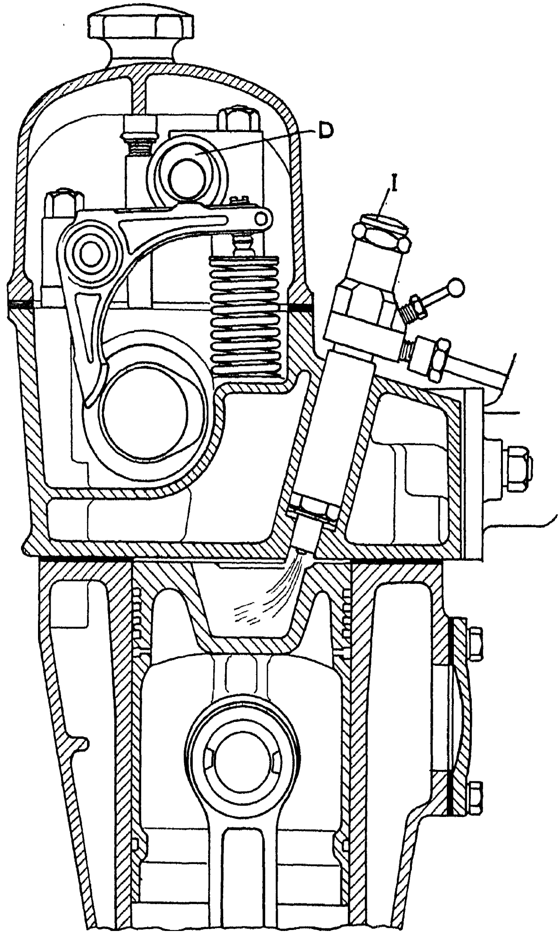


Fig. 1.—THE LEYLAND DIRECT INJECTION CAVITY PISTON ENGINE
Showing the decompressor shaft D.

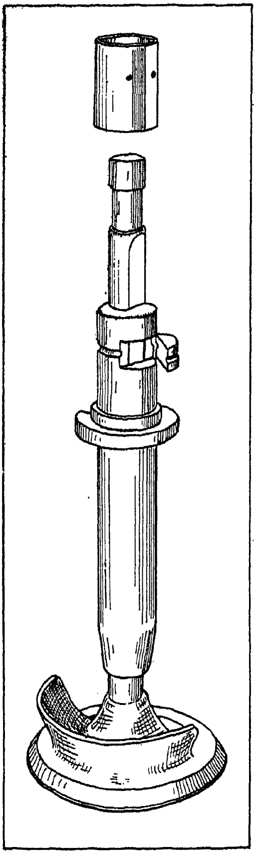


Fig. 2.—THE LEYLAND MASKED INLET VALVE

the cylinder head, and lifts the exhaust valves off their seats.

It is essential, owing to the close proximity of the piston, that the valves be correctly timed or they may be struck by the piston.

Valves

The exhaust valves are of conventional design, but the inlet valves are provided with a screen on one side (*see* Fig. 2). For this reason the inlet valves are keyed in their guides, and to prevent wrong replacement the guides are located by pegs in the cylinder head. The keys are retained by circlips which fit over the valve guides.

Removal of Cylinder Head

To remove the cylinder head, disconnect the exhaust pipe and remove the air cleaner from the manifold. Uncouple the fuel pipes from the nozzles, and remove the leak-off pipes. Drain the radiator and cylinder block (a tap is provided for this purpose in the nearside rear corner of the block). Disconnect the front water connection and remove the thermostat. Disconnect the rear water connection at the rear end of the head. Take off the valve cover and remove the nuts securing the decompressor and rocker gear. To remove the rockers from the shafts, take out the circlips. Two special lifting nuts are provided to facilitate lifting the cylinder head.

The valve seats are stellite faced, and may be dealt with as described on p. 517, except that the working faces are formed at 45°.

Replacing Cylinder Head

To replace the head, turn the engine until No. 1 piston is on top dead centre and the fuel pump has just delivered. The top dead centre mark on the flywheel is visible through an aperture in the nearside of the bell housing. The fuel pump has just delivered when the mark on the coupling has just passed the pointer on the pump. Turn the camshaft wheel until the timing line is level with the cylinder head.

Lower the head on the jacking nuts : when in this position the timing wheels are about to mesh. At this moment care must be taken to see that the teeth of the camshaft wheel do not ride on the teeth of the split

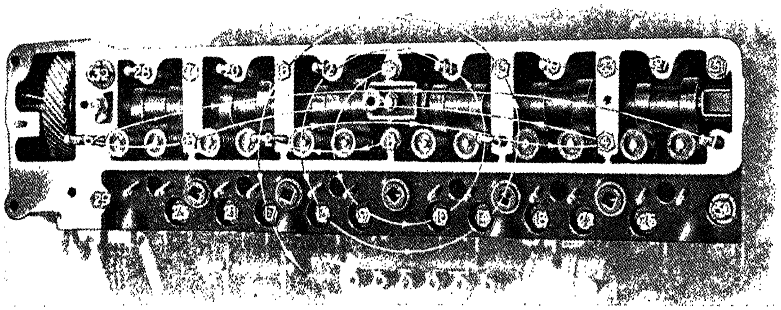


Fig. 3.—ORDER OF TIGHTENING CYLINDER-HEAD NUTS

pinion. Press the sliding part of the gear back by levering between the sprocket and gear with a screwdriver, then engage the teeth.

Check that the timing line is still level with the head, and that the fuel-pump mark has just passed its pointer; the fuel pump rotates in the opposite direction to the engine.

Alternatively, to time the camshaft, lower the head and mesh the gears. Set the engine with No. 1 flywheel mark opposite the pointer and the mark on the fuel-pump coupling just past its pointer. Slacken off the clamp-screws and turn the camshaft until the line on the hub is level with the cylinder head. Tighten the clamp screws dead tight and lock with the locking plates. Replace all the bridge pieces and the nuts.

Tightening Head Nuts

It is important that the cylinder-head nuts are tightened in some definite order. The middle row should be tightened first, commencing at the centre nut; the remainder should be tightened in a widening circle as shown in Fig. 3.

If the engine is in the chassis and the rocker gear has been assembled, on side-type machines, it will be necessary to use the special claw-foot spanner to tighten nuts 15, 16, 23, 24, 31, and 32, Fig. 3, or their equivalents on four-cylinder engines.

If the rocker gear has not been assembled, all the nuts are accessible with a box spanner, but the decompressor shaft must be assembled in its bearings before tightening the nuts which secure the bearings to the head. In this case, when all the nuts have been tightened solid, the decompressor shaft must be removed temporarily to allow the rocker gear to be assembled on the head.

When the cylinder head is tightened down, check that there is ample backlash in the timing gears with the split timing wheel pressed back. The gears are cut specially deep to prevent bottoming, but if they appear tight, a new gasket should be fitted.

Adjust the valve clearances to ·008-in. inlet and ·010-in. exhaust. *Make quite certain that the valve timing is correct and that no valve touches a piston when the engine is turned by hand.* If the timing is half a tooth out, the valves may foul the pistons and cause considerable damage if the engine is run.

Couple up the water connections, fit the delivery pipes, and prime through to the nozzles before connecting the upper unions, by turning the engine with the throttle open. Start up the engine and run till hot, then give the nuts a final tighten and reset valve clearances.

If the engine will not start, check that the feed pipes are primed, and also that the fuel pump is correctly timed, as it is possible to be 180° out.

Timing Gear

The camshaft and auxiliaries are driven by a triplex roller chain. The driving sprocket is keyed on the front end of the crankshaft and the drive taken by sprocket shafts in the crankcase and timing case. Chain stretch due to wear is taken up by an automatic tensioner, a shoe fitted under the fuel-pump sprocket precluding the possibility of slip due to slackness.

Timing Chain

The length of the timing chain is such that the automatic tensioner is at its minimum radius when the chain is new. When the tensioner is at its maximum radius, a new chain should be fitted.

When new, the chain measures 4 ft. $8\frac{7}{8}$ in. when the dynamo is mounted on the engine, and 5 ft. $3\frac{7}{8}$ in. when the dynamo is mounted on the gearbox. The maximum stretch permissible due to wear is $1\frac{1}{2}$ per cent. of its original length. If, when laid on a flat surface with the ends pulled as far apart as possible, the length exceeds 4 ft. $9\frac{3}{4}$ in. for direct drive or 5 ft. $4\frac{7}{8}$ in. for remote drive, a new chain should be fitted.

To remove and replace the chain, proceed as described on p. 520.

The timing marks on the top sprocket and flywheel must be checked for correct relative positions when the chain has been removed; the fuel-pump timing must also be checked. The timing line on the front of the top sprocket should be level with the top of the timing case when No. 1 piston is on top dead centre. The mark on the fuel-pump coupling should be opposite the pointer when the mark "INJ" on the flywheel is opposite the bell-housing pointer.

Fan and Fan Drive

A four-bladed fan is driven through a friction clutch on the top sprocket shaft in the timing case (*see* Fig. 4).

It should be possible to rotate the fan on the centre by pulling on the blades. If the clutch is solid, the fan should be removed and the friction liners eased a little to allow the fan to be turned. If the clutch is too slack, new liners should be fitted.

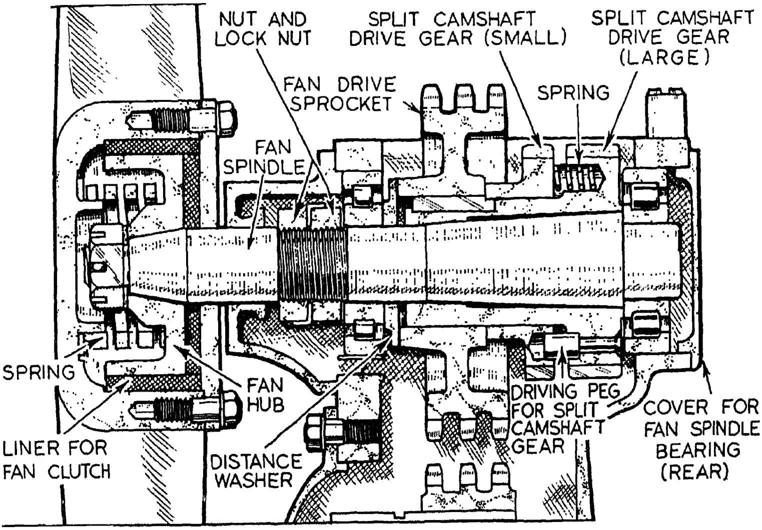


Fig. 4.—FAN AND FAN DRIVE

Top Sprocket and Camshaft Drive

The top sprocket and camshaft drive are also shown in Fig. 4. It will be seen that the camshaft drive pinion is split. The fixed part is mounted on the tapered sprocket shaft, the sliding part is located by dowels and pressed outwards by springs, the movement of the sliding part being limited by the face of the chain sprocket which is keyed on the fixed part of the pinion.

Removing and Replacing Top-sprocket Shaft

To remove the pinion or sprocket, the cylinder head must be lifted and the timing case removed from the engine. Remove the fan and driving centre, take off the housing and cover. Tap the front end of the shaft to release the taper, taking care not to damage the threads, and the shaft can be drawn through the pinion from the rear.

When replacing, see that the distance-washer is in position, and make sure that the nuts are tightened solid and locked with the tab washer. The distance-washer is stepped and must be fitted with the smaller-diameter face to the inner race of the bearing. The roller bearings must be fitted with the lipped side of the outer races outwards, as shown in Fig. 4.

Fuel-pump and Auxiliary Drives

These sprockets are keyed on shafts which are carried in ball bearings, the driving centre for the flexible coupling being mounted on the taper ends of the shafts. The bearings and driving centres are secured on the

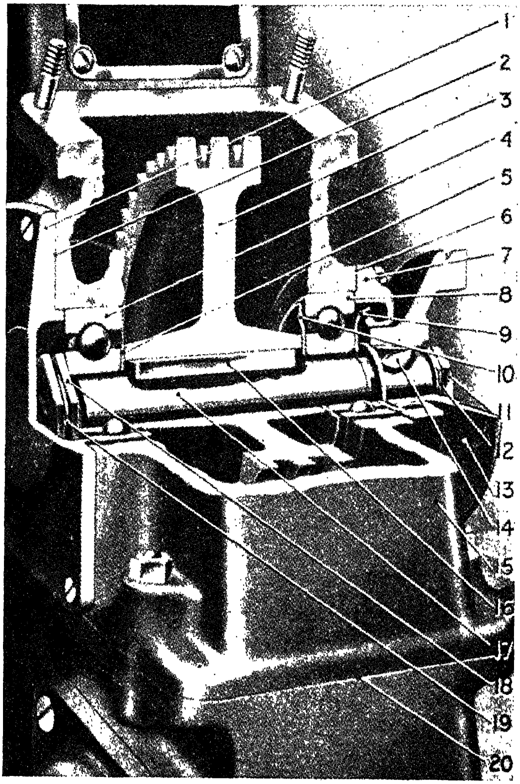


Fig. 5.—SPROCKET-SHAFT ASSEMBLY

(1) Front-cover plate.
(2) Joint for front-cover plate.
(3) Fuel-pump drive sprocket.
(4) Front ball bearing.
(5) Distance-piece for sprocket alignment.
(6) Joint for rear cover.
(7) Rear cover.
(8) Rear ball bearing.
(9) Oil flinger.
(10) Chip guard for rear bearing.
(11) Nut for fuel-pump coupling.
(12) Circlip for nut.
(13) Fuel-pump coupling.
(14) Key for fuel-pump coupling.
(15) Timing case.
(16) Key for fuel-pump sprocket.
(17) Fuel-pump sprocket shaft.
(18) Nut for sprocket shaft.
(19) Circlip for nut.
(20) Joint (timing case to crank-case).

shaft by ring nuts locked by circlips, the outer races of the bearings being located by the covers. Oil flingers are provided to prevent leakage at the rear bearings.

To remove the shafts, take off the covers (1) (Fig. 5), remove the circlips (19) and ring nuts ; a special spanner is provided. Take off the nuts from the rear covers (7), and gently tap the shafts through from the front until the sprocket shafts are free and can be removed.

When replacing see that the ring nuts are tightened solid and locked with the circlips, and that the sprockets are good fits on the keys. All distance-washers must be fitted in their original positions, as they are fitted for chain-alignment purposes.

In the event of oil leakage from the rear covers, check that the oil-return holes in the covers are clear.

Oil Passages

Clean out all the passages in the timing case during overhaul and check occasionally that there is an adequate supply of oil to the cylinder head.

Ensure that the oil-gauge connections are always kept tight. Inspect at frequent intervals to see that no chafing is occurring on any part of the oil-gauge pipe. A small tap is provided in this pipe (near the oil filler) to enable the oil supply to the pressure gauge to be cut off temporarily in the event of a fractured pipe. Check that the outlet to the small feed pipe for timing chain lubrication is not choked.

Cylinder Liners

At overhaul the bores should be measured, and when the maximum diameter exceeds + ·015 in. at the top, or + ·006 in. half-way down the stroke, new liners should be fitted. In the case of earlier engines not fitted with liners, the cylinders should be bored out and liners fitted. It is recommended that blocks requiring relining should be returned to a Leyland service depot.

In the case of unlined blocks the cylinders should be bored out to $4\frac{11}{16}$ in. with limits of + ·000 in. to − ·003 in., which will give an interference of ·003 in. to ·006 in. when pressing in the liners. Liners are supplied finished ground on the outside ready for pressing in.

After pressing in, the liners must be ground to size + ·001 in. to − ·000 in.

Pistons

The pistons are of aluminium alloy and have an open cup offset from the centre of the crown. Four compression rings and one scraper ring are fitted. The pistons are oval and taper ground, and have a normal clearance of ·008 in. at the top of the skirt, and ·006 in. at the bottom. Care must be taken when replacing pistons that the cup is offset towards the nozzle side of the engine. The pistons normally are flush with the top of the block when on top dead centre; they must not project more than $\frac{1}{64}$ in. or they may strike the valves.

Piston Rings

The compression rings are fitted at the top of the piston, the scraper ring in the bottom groove. The groove in the skirt is provided so that, should the oil consumption warrant it, an extra scraper ring may be fitted at the most convenient dock. Rings should have from ·005 in. to ·003 in. clearance in their grooves, and should be replaced if clearance exceeds ·010 in. for top ring and ·008 in. for the remaining rings. Ring-gap clearance ·007–·009 in. when new, not to exceed ·030 in.

Big-end Bearings

The top half of the big-end bearings is of aluminium alloy, the lower half is a steel shell white-metal lined. Play in the big ends should not exceed ·006 in., and play should be taken up by fitting new bearings or filing the connecting rods and caps. The former is recommended, as new

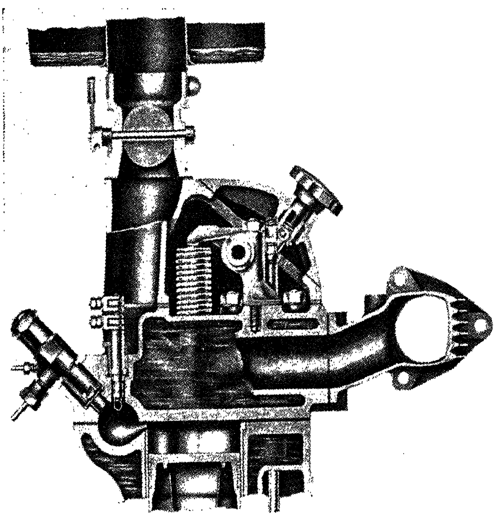


Fig. 6.—THIS SHOWS THE LEYLAND AUXILIARY TURBULENT COMBUSTION-CHAMBER HEAD IN SECTION

connecting rods and caps will be required, if the others have been filed, when the crankpins are reground and undersize bearings fitted. Crankpins should be reground when more than ·003 in. oval; undersize bearings in steps of ·005 in. are available and four regrinds are permissible.

When filing connecting rods and caps, extreme care must be taken to ensure that the faces are filed true and perfectly flat, so that they bed all over when bolted up. A clearance of ·0015–·003 in. should be allowed on the crankpins, and the connecting rods should be checked for alignment when bolted up. Bolts must be pulled up dead tight, and on no account must they be slackened off if the bearings are too tight or to bring the pinholes into line. The bearings must be scraped to a fit and the nuts filed if necessary to bring the pinholes into line, care being taken to keep the faces true.

Crankshaft

The crankshaft is supported in five and seven main bearings on four- and six-cylinder engines respectively. All journals and crankpins are 3 in. in diameter. Oilways are drilled in the crankshaft from the journals to the crankpins. The rear journal is drilled eccentrically to allow oil-mist to pass to the clutchshaft spigot-bearing.

The timing-chain sprocket and oil-pump driving gear are keyed on the front end of the crankshaft and locked by the starting dog which screws into the end of the crankshaft and is locked by a tab washer.

ANTE-CHAMBER TYPE OF OIL-ENGINE

As with the Light Six petrol engine, the Light Six oil-engine is fitted to Lynx chassis. The overhead valves are operated by push-rods and rocker arms. Provision is made for valve-stem clearance adjustment at the push-rod side of these rocker arms.

The correct clearance is ·020 in. for both inlet and exhaust with a cold engine. When adjusting valve clearances, the tappets should be on the

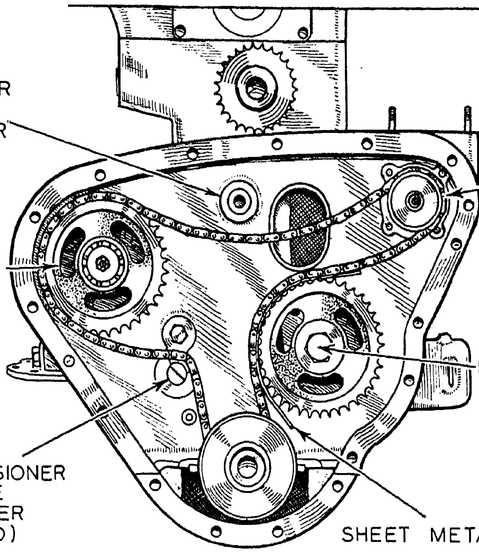


Fig. 7.—TIMING THE CAMSHAFT

back of the cams and the engine should be turned until the valve is closed and the tappet approximately in this position. If the piston is on top dead centre on the compression stroke, the valves for that cylinder will be in a suitable position for adjusting clearances.

Valve Timing

The valve timing is as follows :

			On flywheel.
Inlet opens	5° before	T.D.C.	·76 in.
Inlet closes	35° after	B.D.C.	5·33 in.
Exhaust opens	44° before	B.D.C.	6·1 in.
Exhaust closes	6° after	T.D.C.	·91 in.

Valve Guides

To fit new valve guides drive the old ones out from inside the head ; check that the new ones when driven in from the outside are right home. Exhaust-valve guides should have clearance of from ·0055 in. to ·008 in. on the valve stems.

Removing Camshaft

To withdraw the camshaft, remove the radiator, drop the sump and remove the oil pump. Remove the tappets complete in their brackets by taking out the setscrews securing the brackets to the block. Take off the timing-case cover, taking care to support the engine, as described under " Timing Chain." Withdraw the chain tensioner and idle sprocket

and the chain can be removed without taking out a link. The two screws securing the thrust-washer can be removed through the holes in the camshaft sprocket, and the camshaft withdrawn. The sprocket is keyed on the camshaft (two keyways, giving a half-tooth variation, being provided to assist in timing when a new sprocket is fitted) and secured by a nut and tab washer. If the thrust-washer is badly scored or worn, a new one should be fitted; end play on the camshaft with a new thrust-washer should be from ·0025 in. to ·0045 in.

Replacing the Camshaft

Feed in the camshaft, tighten up the thrust washer, and fit the timing chain before replacing the idle sprocket and chain tensioner.

Timing the Camshaft

It is most important that the camshaft is correctly timed before attempting to start the engine. If the timing is incorrect, the valves may strike the piston and cause serious damage.

Set the valve clearances on No. 1 cylinder at ·020 in. both inlet and exhaust. Insert a piece of thin sheet metal or stout paper round the camshaft sprocket, as shown in Fig. 8, to hold the chain clear of the sprocket. Set the engine with No. 1 and 6 mark on the flywheel ·76 in. before the mark on the housing. Turn the camshaft in direction of rotation (anti-clockwise looking from the front of the engine) until No. 1 inlet valve is just about to leave its seat, then remove the sheet metal and mesh up the chain without slack between the crankshaft sprocket and camshaft sprocket. Check over the timing on No. 1 exhaust valve and on No. 6 cylinder.

If a new sprocket has been fitted and there is slight slack in the chain between the sprockets when meshed up, the timing is probably a half-tooth out, and this can be remedied by fitting the camshaft sprocket on the other keyway.

Replace the idle sprocket and the chain tensioner, keeping the eccentric at its minimum radius when sliding on its spindle.

The fuel pump must be retimed as outlined.

Timing Chain

A new chain is of such length that when fitted the tensioner is at its minimum radius; when the tensioner has reached its maximum radius the chain should be renewed. The chain consists of 130 pitches by $\frac{3}{8}$-in. pitch, and the maximum stretch permissible due to wear is $1\frac{1}{2}$ per cent. of its original length. If, when laid on a flat surface with its ends pulled as far apart as possible, the length exceeds 49·4 in., a new chain should be fitted.

To inspect or remove the chain, the radiator must be detached, the crankshaft damper removed, and the fan pulley withdrawn. If the engine

is in the chassis, it will be necessary to support it on packings before removing the timing case cover, as the engine foot is made integral with the cover. Release and withdraw the chain tensioner and idle sprocket and the chain can be removed.

Sprocket Shafts

The dynamo and fuel-pump sprockets are keyed on their shafts and run in ball bearings. The back bearing is pressed on the shaft against a shoulder, the sprocket is keyed and the front bearing pressed on, the whole being locked with a nut and split-pin. The couplings are keyed on the shafts and locked by nuts and split-pins. Oil flingers are fitted behind the back bearings, and shims are fitted for chain-alignment purposes.

To remove the auxiliary shafts, unscrew the nuts and draw off the front bearings. Remove the back covers and tap the shafts through the sprockets, taking care not to damage the threads.

Pistons

The pistons are of aluminium alloy, and are fitted with four compression rings and one scraper ring, a further slot being provided in the skirt to allow another scraper ring to be fitted. This additional ring should be fitted if the oil consumption becomes excessive. Pistons are oval and taper ground, ample clearance being provided around the gudgeon-pin bosses. The normal clearance allowed is ·010 in. on the ring lands and ·004 in. on the skirt. Pistons are numbered and should be replaced in their correct cylinders, with the numbers to the tappet side of the engine.

Piston Rings

The four compression rings are fitted at the top of the piston and the slotted-type scraper ring in the bottom groove. If the rings have more than ·006-in. play in the grooves, or the gap exceeds ·020 in., new rings should be fitted.

When fitting new piston rings, they should have from ·001–·002-in. play in the grooves, and a gap of ·010 in. for the top ring and ·008 in. for lower rings. The gap should be tested with the ring half-way up the bore, after squaring up with the top of a piston.

Big-end Bearings

No shims are provided for adjusting the big-end bearings, and the caps should not be filed. New bearings should be fitted if play is excessive and the crankshaft reground if the pins are ·003 in. oval. Undersize bearings in steps of ·005 in. are available for use with reground crankshafts, and four regrinds are permissible.

When fitting new bearings, they must be scraped to show at least a 75-per cent. bed with ·001–·002-in. clearance on the shaft and ·002–

·003-in. end play. The bearings should rotate freely on the pins without oil when the caps are tightened up. Bolts must be tightened hard, and on no account must they be slackened back if a bearing is too tight. If the pinholes are not in line, the nuts must be filed, care being taken to keep the faces true.

Cylinder Liners

Service liners are available in two forms : finished ground on the outside only, and finished ground both outside and in the bore. The former are intended for use at overhaul when a complete set of liners is to be fitted. The latter are primarily for fitting odd liners with the engine in the chassis in the event of damage to a single bore. A special tool has been developed to facilitate removing and fitting these liners.

New liners should be fitted when the bore is ·007-in. oversize at the top or ·006 in. half-way down the bore.

Fuel-pump Timing

The fuel-pump timing is correctly set before delivery and should not be altered, as there is nothing to be gained and much to be lost by such alteration. Injection begins 29° before top dead centre when checked by spill from the pipe end. This corresponds to actual injection under pressure 11° before top dead centre.

If the timing chain has been removed, turn the engine to the timing position, No. 1 cylinder on compression (both valves closed) and the "INJ" mark in the same position relative to the indicator as before removal. Replace the pump with all timing marks in line, and fit the timing chain. The camshaft must then be checked for correct timing (*see* "Timing the Camshaft"). Any minor adjustment can be made by means of the vernier on the pump coupling.

Firing Order

The firing order is 1, 5, 3, 6, 2, 4. The pump can be checked for correct injection by disconnecting the delivery pipes and observing the fuel as it appears at each pump outlet when the engine is turned. The pump rotates in the same direction as the engine.

THE THORNYCROFT TC/4 POWER UNIT

THE TC/4 power unit, which comprises the petrol engine, gearbox, and clutch, is fitted in the Thornycroft Sturdy and Nippy class chassis.

The following is a brief specification of the power unit:

No. of cylinders	4
Bore . .	$3\frac{7}{8}$ in. (98·4 mm.)
Stroke . .	5 in. (127 mm.)
Cu. capacity .	235·8 cu. in. (3,865 c.c.)
R.A.C. rating	24·03 h.p.
B.h.p. @ 1,000 r.p.m.	31
Maximum b.h.p. .	62

Cylinders.—Monobloc construction, assisting rigidity of engine. The cylinder head is easily detachable for decarbonising and grinding-in the valves. Renewable dry cylinder liners, aluminium-alloy pistons, side-by-side valves, and detachable exhaust-valve seats are fitted.

Valve Gear.—Operated by adjustable tappets, and easily reached through two large covers on the side of the cylinder block.

Crankshaft.—Dynamically and statically balanced and carried in three white-metal lined bearings of large diameter.

Lubrication.—Forced-feed system, from a rotary-gear pump, delivering oil to the main and connecting-rod bearings, also to the camshaft bearings. Before returning to the sump, which has a capacity of 2 gals., the oil passes through a large metal strainer.

Ignition.—By coil and distributor. The manufacturers will fit as an alternative, if specially requested to, a high-tension automatic-advance magneto.

Carburettor.—Float-feed automatic type, with hot-spot induction system, ensuring maximum economy and efficiency.

Cooling System.—By belt-driven pump and fan, mounted on the front of the cylinder block. The tension of the belt is adjustable.

Clutch.—Single-plate dry type.

Gearbox.—Unit with engine and clutch, and providing four forward speeds and a reverse speed. The gear shafts are carried on ball-and-roller bearings. The change-speed lever is on the driver's left hand, and mounted direct on the gearbox.

Gear	*Ratio*
Top	Direct
Third	1·795
Second	3·14
First	6·41
Reverse	9·27

Care of New Engine

With each new vehicle delivered, the manufacturers issue an instruction manual which is designed to be of assistance to owners and drivers. In the foreword of this manual they stress the necessity for "running in" a new engine for at least five hundred miles, as considerable wear can be caused by misuse and lack of attention during this period.

After the first one thousand five hundred miles, the manufacturers suggest that the following work should be carried out: cylinder head lifted, and engine decarbonised; valves and seats attended to; oil strainer removed and cleaned, and engine oil changed. From this stage in the life of the engine it is advisable to carry out repairs and adjustments at fixed periods, which of course will be determined by the service and conditions under which the vehicle is operating. For those who are called upon to carry out these repairs and adjustments, and particularly those who have no access to the instruction manual, the following paragraphs will perhaps be helpful.

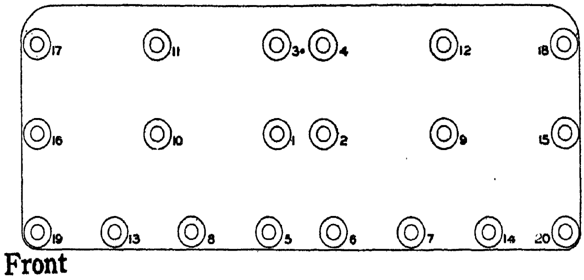
Cylinders and Cylinder Head

The cylinder block and top half-crankcase are cast integral, and dry liners, of special wear-resisting material, are pressed into the cylinder barrels. These liners have the advantage of being replaceable in the unlikely event of piston seizure, thus eliminating the necessity and expense of grinding the complete block and fitting oversize pistons.

Exhaust-valve inserts, of special heat-resisting material with stellite faces, are fitted, and provision has been made on the cylinder-block casting for the fitting of inlet-valve inserts should they be required. The manufacturers have a special tool for inserting these valve inserts, and, if necessary, they are at all times prepared to send a mechanic to carry out this work.

The tappets and their guides are of generous proportions, and are readily accessible through the tappet doors in the left side of the engine. Should they require to be removed, unscrew the two nuts holding the tappet block to the cylinder casting and lift the tappet block away. As a precautionary measure, guards have been fitted to the tappet blocks to prevent nuts, spanners, etc., from dropping directly into the engine interior.

If the cylinder head is to be removed, drain off the water, take off the bonnet and, on the normal-control chassis, remove the radiator tie-rod. Disconnect the top water pipe, also the high-tension leads, and remove the distributor complete with its bracket. Take off the tappet-chamber doors, and lift the distributor driving shaft out through the top. Unscrew all nuts on the cylinder head, and lift the head off. Lugs are incorporated on the cylinder head to facilitate its removal, but screwdrivers or chisels should not be used to prise it up, or the gasket and the edges of the cylinder head and block will be damaged.



1.—PLAN OF CYLINDER HEAD

When replacing the cylinder head, it is advisable to fit a new gasket; see that the faces of the cylinder block and head are quite free from grit and dirt, making sure to clean all particles of carbon from round the base of the studs. Lower the head gently into place, and screw down all the nuts until they just begin to grip, then tighten down a little at a time, in the order indicated on the illustration. When the engine has been run and is warm, go over the nuts again, and give them a further tightening in the sequence shown in the illustration. It is also essential to tighten the head down on its gasket after it has run a further two hundred to four hundred miles.

Decarbonising and Grinding-in Valves

The valves are responsible for the behaviour of the engine to a very large extent, and will require grinding-in from time to time, as indicated by loss of compression, but this operation will be necessary only at long intervals provided the correct tappet clearances have been maintained.

When grinding-in the valves, be sure that each valve is ground into the same port from which it was taken ; to ensure this they are numbered accordingly. The inlet and exhaust valves can be distinguished by the number of holes drilled in the head. The exhaust valve has two holes and the inlet four.

Clean off all carbon from cylinder head, valve ports, and pistons, not forgetting the exhaust manifold, "hot spot," and induction manifold. If the valves are badly pitted, they should either be renewed or be skimmed up, and warped valves discarded. See that the stems work freely in their guides, and, if necessary, clean with fine emery cloth. After being ground-in, all traces of the grinding paste should be scrupulously wiped off before replacing the valves.

After grinding-in the valves, always reset the clearance between the valve stems and tappets.

Adjusting Tappets

It is important that the tappet which is being adjusted is at its lowest position of travel, and to ensure this the engine should be turned about

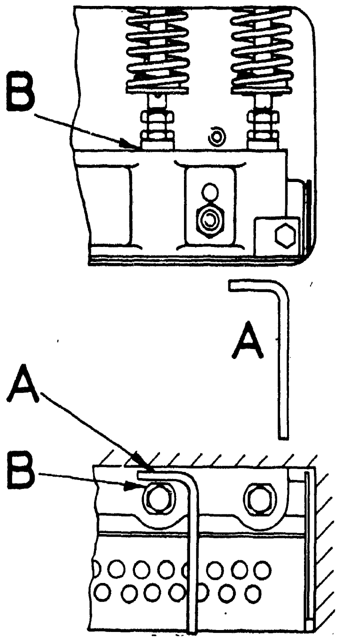


Fig. 2.—DIAGRAM FOR TAPPET ADJUSTMENT

A special tool *A* is provided in the tool kit to prevent the valve tappet rotating while being adjusted. It is used as shown.

half a turn after the valve has closed. A special tool is provided with each tool-kit to prevent the valve tappet rotating while being adjusted (*see* Fig. 2). The shorter end of this tool, marked *A* in the illustration, should be inserted between the flat on the side of the tappet and the cylinder block, at point marked *B*.

Adjustment is made by slackening the locknut and adjusting the tappet screw until the gauge, ·008 in. for inlet valve, and ·012 in. for exhaust valve, is a close sliding fit between the valve stem and the tappet screw. Now tighten the locknut and recheck, as tightening this nut may alter the clearance slightly.

Camshaft

The camshaft is driven by a triplex roller chain, and endwise location is effected by a cast-iron thrust-plate at the back of the sprocket. The camshaft is carried in aluminium-alloy bushes secured by locating screws through the side of the crankcase.

Timing Wheels and Chain

If the timing chain or gears require attention, the fan-driving pulley must be drawn off and the support plate for the front engine bracket taken off before the front cover can be removed. Undo all the bolts and nuts round the edges of the front cover and along the edges of the sump. Lower the sump and remove the front cover.

Valve Timing

When any part affecting the valve timing has been removed, the chain must be refitted to obtain the correct setting again.

To do this, turn the engine until No. 1 crank is $14\frac{1}{2}°$ past top dead centre, then rotate the camshaft sprocket until the timing mark on the rim is in line with the small hole in the chain-case flange above it, and then engage the chain. The dynamo driving sprocket may be in any position when meshed with the chain.

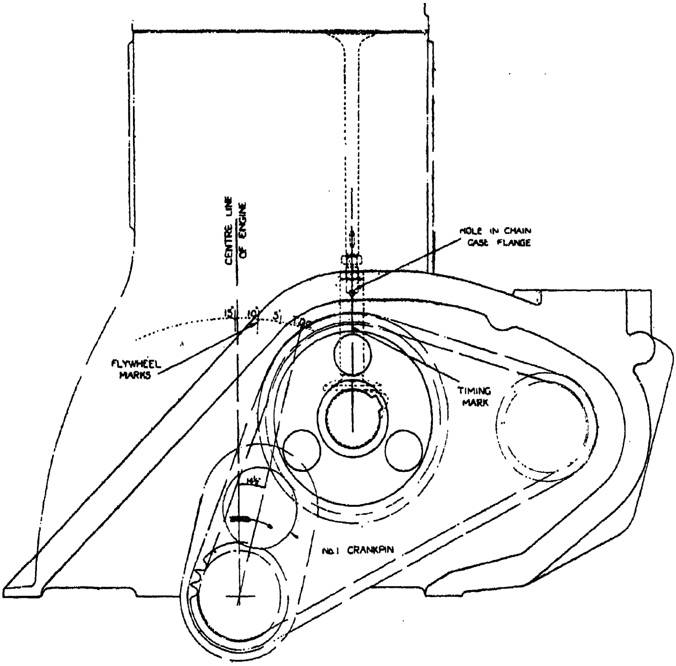


Fig. 3.—VALVE-TIMING MARKS

After the sprocket wheels have been set, check the opening of the inlet valve, or the closing of the exhaust, for No. 1 cylinder, i.e. the one at the front of the engine. The inlet valve should begin to open 15° before top dead centre, and the exhaust just close $14\frac{1}{2}$° after top dead centre, but these figures may vary plus or minus 5°. Before checking the timing, the tappets should be set to their correct clearances. These are ·008 in. for the inlet and ·012 in. for the exhaust, when the engine is cold.

The flywheel rim is marked in degrees, and the figures can be read through the small inspection hole on the top of the clutch housing. The top-dead-centre position of No. 1 piston will be obtained when the line on the flywheel marked " No. 1 T.D.C." lies across the centre of the inspection hole. It is necessary to check only one valve, as all the cams are integral with the shaft. When the timing is correctly set, replace the dismantled parts and bolt up the front cover, etc., taking care to ensure oil-tight joints.

Chain Adjustment

The amount of slackness in the timing chain can be ascertained by feeling the free rotary movement of the fan-driving pulley when the engine is at rest. A slack chain can also be detected by the unusual noise when

the engine is idling, especially if it is sufficiently slack to slap against the timing case.

The chain is adjusted by swinging the dynamo bracket on its lower bolt. Slacken off the three $\frac{7}{16}$-in. bolts holding the dynamo bracket, also loosen the three $\frac{5}{16}$-in. nuts on the front ball-bearing housing of the dynamo drive. The three $\frac{5}{16}$-in. nuts on the coupling-side dynamo bracket must not be slackened under any circumstances.

To tighten the chain pull the dynamo bracket away from the engine, preferably by means of a strip of wood, about 1 in. square and 15 in. long, used as a lever, until there is not more than a $\frac{1}{8}$-in. movement measured at the circumference of the fan-driving pulley. The chain should never be adjusted to dead tight; there must always be some free movement of the fan-driving pulley, otherwise the chain will be unduly stretched, and also a severe load imposed on the bearings near all chain sprockets. Should the chain still be slack when the bracket is moved over to its extreme position, a new chain should be fitted.

When this adjustment has been made, tighten the three $\frac{7}{16}$-in. bolts holding the dynamo bracket before tightening the three $\frac{5}{16}$-in. bolts on the front ball-bearing housing.

The chain adjustment should be checked at regular intervals of five thousand miles, or every three months, as, if the adjustment is neglected, there is a possibility of the chain jumping the teeth on the camshaft wheel and altering the valve timing. A loose chain is most likely to jump its sprocket when the engine is switched off or finally coming to rest, not when pulling steadily. Sudden loss of compression when restarting an engine is a sure sign of a neglected timing-chain adjustment, and that the chain has jumped the teeth of the sprocket.

The engine can be retimed as follows:

(1) Slacken off the adjustment of the chain to its fullest extent.

(2) Remove the rear-tappet door and tappet shield.

(3) Turn the engine carefully until No. 4 inlet tappet is just about to lift the valve, and insert the jaw of a suitable-sized spanner between the tappet head and tappet block, so as to prevent the camshaft turning.

(4) Turn the engine by means of the starting-handle until the flywheel marking of 15° before top dead centre is in the centre of the small orifice at the top of the flywheel housing.

(5) Readjust the timing chain, and check timing.

Coil Ignition

Considering the exacting duties coil ignition has to perform, the attention needed to ensure absolutely reliable service is very small.

The ignition is provided with an automatic timing mechanism, which automatically varies the firing-point according to the requirements of the engine. After the first five hundred miles' running, it is usual for the vehicle to be taken to a service station to have various minor adjustments

made to the engine. At the same time the contact-breaker gap must be set to ·012 in. maximum open, and the cam must be given a smear of vaseline, as it has been found that most of the bedding-down of the contacts occurs during this period.

The following parts of the distributor require lubrication :

(1) *Distributor Shaft.*—Add a few drops of thin machine oil, through oiler provided, about every one thousand miles.

(2) *Cam.*—After greasing at the end of the first five hundred miles, give the cam a smear of vaseline every three thousand miles.

(3) *Cam Bearing.*—About every three thousand miles withdraw the moulded rotating arm from the top of the spindle by pulling it off, and add a few drops of thin machine oil. Do not remove the screw exposed to view, as there is a clearance between the screw and the inner face of the spindle through which the oil passes to lubricate the cam bearings. Take care to refit the arm correctly, and to push it on to the shaft as far as possible, otherwise there is a risk of tracking and burning of the moulding.

(4) *Contact-breaker Pivot.*—Every five thousand miles place a spot of oil on the pivot on which the contact-breaker rocker arm works.

Keep the outside of the distributor clean, particularly the spaces between the high-tension terminals. Very occasionally, remove the moulding by springing aside its two securing spring clips. Wipe the inside clean with a dry cloth, and see that the carbon brush is quite free in its holder. Clean the metal electrodes inside the moulding, and also the rotating electrode on the distributor arm ; if necessary, use a cloth moistened with a drop of petrol for this.

Next, examine the contact breakers ; you must keep the contacts free from any grease or oil. If they are burned or blackened, clean them with fine carborundum stone, or if this is not available you can use very fine emery cloth. Finish off with a cloth moistened with petrol, and remove all traces of dirt and metal dust. Misfiring is sometimes caused by dirty contacts.

After the contacts are reset at the end of five hundred miles' running, they require only occasional adjustment. The chief cause of variation in the gap is wear of the heel of the contact rocker arm which bears upon the actuating cam. Provided the cam is kept smeared with vaseline, however, the wear on the heel will be negligible, and the contact-gap setting should require adjustment only at infrequent intervals.

To check the setting, turn the engine by hand until the contacts are fully opened ; now insert a ·012-in. feeler between the contacts. This should be a sliding fit when the gap is correct. It is not necessary to alter the setting unless there is quite an appreciable variation from the gauge. To make the adjustment, keep the engine in the position to give maximum opening of the contacts and slacken the two screws securing the contact plate. Then move the plate until the gap is set to the thick-

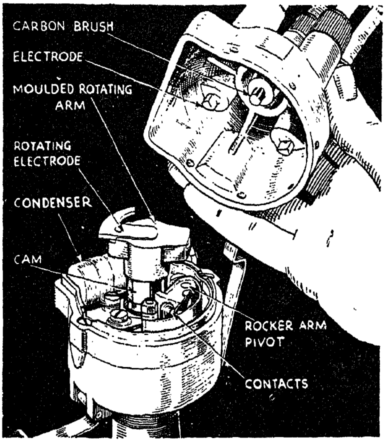


Fig. 4.—DISTRIBUTOR ON TC/4 ENGINE

ness of the gauge. After making the adjustment, care must be taken to tighten the locking screw.

The high-tension cables are those connecting the coil to the distributor, and the distributor to the sparking plugs. When these cables show signs of perishing or cracking, they must be replaced by 7-mm. rubber-covered ignition cable. The method of connecting the cable is to thread the knurled moulded nut over the lead, bare the end of the cable for about $\frac{1}{4}$ in., thread the wire through the brass washer provided, and bend back the strands. Finally, screw the nut into its respective terminal.

The coil requires no attention whatever beyond keeping its exterior clean, particularly between the terminals, and occasionally checking that the terminal connections are quite tight.

Ignition Switch and Warning Light

The ignition switch, besides forming a means of stopping the engine, is provided for the purpose of preventing the battery being discharged by the current flowing through the coil windings when the engine is stopped. A warning lamp is provided in the instrument panel, which gives a red light when the ignition is switched on and the engine is running very slowly or is stationary, thus indicating that the ignition has not been switched off. Should the warning-lamp bulb burn out, this will not in any way affect the ignition system, but it should be replaced as soon as possible in order to safeguard the battery.

Timing Ignition

Turn the engine until the top-dead-centre mark on the flywheel is in the centre of the inspection hole on the compression stroke of No. 1 cylinder, then turn the engine backwards 5°, set the vernier to the 0-position, and slacken the bolt locking it to the distributor, so that the latter can be rotated by hand. Rotate the distributor body until the contacts just break, and tighten up the bolt locking it to the vernier adjustment.

Sparking Plugs and High-tension Wires

If one cylinder misfires continually, the trouble is usually due to the sparking plug, and the changing of this with a spare plug will prove an immediate remedy. Failure is often due to excessive sparking-plug gaps.

The engine will not run smoothly at low speeds, or start easily, if the gaps vary much. It is advisable to remove, clean, and reset the points fairly frequently, say every five thousand miles. To obtain the best results the gaps should be set at ·020 in. to ·022 in. If the plugs are examined periodically, and the points kept to this adjustment, much trouble, for which the coil and distributor may be unnecessarily blamed, will be overcome.

If the high-tension wires are removed from the sparking plug or distributor, they should be connected again in the following order: The cable from No. 1 terminal of the distributor must be attached to the sparking plug of No. 1 cylinder, the remainder being connected as follows:

Distributor Terminal	*Sparking Plug*
No. 2	No. 3
No. 3	No. 4
No. 4	No. 2

It will be seen that the cables are not connected in sequence to the corresponding cylinder number, but in accordance with the firing order of the engine, and to facilitate connecting the cables to the right plugs, different-coloured cables are used; it should be noted in which order they are arranged before disconnecting them from the sparking plugs.

Crankshaft and Main Bearings

The crankshaft is carried in the upper half of the crankcase in white-metal lined bearings, the end location being taken by the centre bearing. Oilways are drilled in the crankshaft from the main bearings to the crankpins, and a spiral oil-return groove at the rear end of the crankcase prevents oil leakage from the rear bearing into the clutch housing.

The main bearings are of the shell type, the bottom halves being located in the bearing caps by dowels. The stud holes in the bearing caps are offset from the centre-line of the bearing, so it is impossible to replace the cap the wrong way. All the main bearings and the caps are numbered in order, starting from the front end of the engine. The cap is stamped on the right side and the corresponding number marked on the crankcase.

Adjustment of the main bearings is provided by shims of ·002-in. and ·003-in. thickness, and as the stud holes in the bearing are offset, care must be taken to fit each shim on the correct side of the bearing. When all the adjustment has been used up by the removal of the shims, new half-shells should be fitted or the old ones must be remetalled. On no account should the bottom half-shell and bearing cap be filed to provide further adjustment. Undersize half-shells can be provided when the crankshaft has been reground.

When bolting up the bearings the nuts should not be slackened back, either to ease the bearing if too tight, or to bring the pinhole in line with a

castellation in the nut ; the bearing should be fitted to a running clearance and the nut be filed to suit the pinhole.

Pistons and Connecting Rods

Steel connecting rods are used, with white metal run directly into the big ends. All the rods are plainly marked for fitting, numbers referring to their respective cylinders being stamped on the left side.

The small end is bronze bushed and is splash lubricated, the fully floating gudgeon pin being located end-ways by circlips sprung into grooves cut in the piston bosses.

Provision is made for taking up the big end by a laminated shim between the body of the rod and cap. The rod is fitted with a ·032-in. shim made up of ·002-in. laminations, and these should be utilised for adjusting the bearing. When all the laminations have been removed the rod should be remetalled. Users are advised to return the rod to the nearest Thornycroft branch, when a service rod will be sent and a small charge made to cover the cost of remetalling.

On no account must the rod or cap be filed to take up the slack bearing. If a returned rod is found to have been filed or is defective in any way, the full cost of the replacement rod will be charged. Rods with undersize bearing can be supplied when the crankshaft has been reground.

An aluminium piston is fitted with two compression rings and one slotted oil-control ring. When fitting new rings, a gap of ·005 in. to ·009 in. should be allowed for the compression and oil-control rings when they are square in the cylinder.

If the pistons and connecting rods are to be removed, they can either be pushed up through the cylinder when the head is off and withdrawn from the top, or be removed through the crankcase, as more convenient. The cylinder head need not therefore be disturbed should a piston removal be necessary. When the big-end cap is taken off, be careful not to damage the shims ; they must be put back exactly as they were before if no adjustment is to be made. Take care that the big end of the connecting rod does not score the cylinder bore if it is drawn up through the top.

Cooling System

The fan and water pump are mounted as a unit on the front end of the cylinder block, and are driven by belt from the dynamo-drive shaft. The belt is adjusted at the dynamo shaft by an adjustable pulley, the adjustment being made by slight rotation of the loose flange after the two setscrews securing it have been slackened off.

Water circulation is provided by a centrifugal pump driven from the end of the fan-pulley shaft. The water seal is formed by a flange on the impeller carrier being held against a carbon ring by spring pressure. A

slight leakage may occur with a new carbon ring, but this will cease after the ring has bedded in.

The only attention the unit should need will be periodic application of grease to the bearings. The greaser is located on the bearing housing.

To fit a new sealing ring proceed as follows :

(1) Drain off the water.

(2) Uncouple the water-inlet pipe, take off the belt, undo the nuts holding pump to cylinder block, and remove the entire unit.

If necessary, the fan can be taken down first by undoing the nuts on its hub.

(3) Separate the fan bearing housing with its shaft and pulley from the pump cover by undoing the four nuts, then remove the pump-cover plate. Unscrew the impeller from the carrier, and the carbon ring is then exposed and can be removed.

When fitting a carbon ring do not knock it into position, as this is likely to crack it. Press the ring firmly with fingers only into the rubber securing ring. Clear any traces of grease from pump casing before fitting new ring, and see that fan and pump spindle engage easily, also compression spring is not too corroded. If any grease gets on to the rubber ring it will soften and come away from the carbon, and cause a severe water leak. If the spindles do not engage easily, the compression spring will not create sufficient end-thrust to seal the carbon ring against the water pressure.

The pump can now be fitted up as a complete assembly before replacing on the engine.

The whole can then be attached to the pump body on the engine.

A drain cock is fitted at the rear end of the cylinder jacket, and another in the bottom of the radiator, by which the water system can be completely drained.

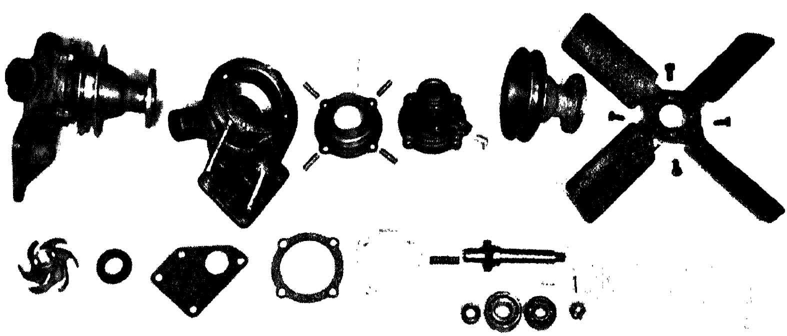


Fig. 5.—THE ASSEMBLY AND COMPONENT PARTS OF THE COMBINED TC/4 FAN AND WATER PUMP

Lubrication

In considering the question of lubrication, users should remember that they are dealing with an engine of considerable size, weight, and horse-power, which may be required to pull heavy loads at comparatively low speeds in a freight vehicle, or to propel a high-speed passenger coach.

It is therefore essential that an entirely suitable lubricating oil be used in the engine. With inferior or unsuitable oils the high temperatures reached in the cylinder walls, pistons, etc., may cause excessive carbon deposit, crankcase sludge, and choked oil ways, with their attendant troubles.

Do not mix one brand of oil with others, as this is liable to cause gumming up, owing to the different oils not blending properly. If it is necessary to change the brand, then the sump should be thoroughly washed out with a flushing mineral oil before the new oil is poured in.

In selecting a lubricant it would be well to bear in mind the particular conditions under which the vehicle is to be garaged and run.

For example, easy engine starting under cold conditions requires a thin oil, while high day temperatures admit the use of a thicker oil.

Oil Pump

The circulation of the oil is effected by a gear-type pump, driven off the camshaft by skew-gears. The oil is drawn from the sump and delivered under pressure through the crankcase to the crankshaft and camshaft bearings, and through the drilled holes in the crankshaft to the connecting-rod big-end bearings. Oil ejected from the big-end bearings lubricates the cylinder walls, pistons, tappets, etc. The oil returns to the sump through a perforated metal strainer over the sump, which prevents pieces of carbon falling into the oil.

The maximum pressure of the oil is controlled by a relief valve on the left side of the crankcase, at the rear end. This relief valve is set to operate at a predetermined pressure, and under normal conditions should not be interfered with. An oil-pressure indicator incorporated in the pressure system is located near the relief valve, and is connected to the green warning light on the instrument panel. While this is alight the oil circulation is in order, but should the light go out, whilst the engine is running, the engine should be stopped at once and the cause ascertained.

The correct oil level in the sump is indicated by a mark on the dip-rod, and it is advisable to examine this every day and replenish as necessary. Fill to the " maximum " mark on the dip-rod, and not over this mark, as excess oil may be splashed on to the cylinder walls by the connecting rods, and result in oiled-up sparking plugs or smoky exhaust. A " minimum " mark is also indicated on the rod, below which it is not safe to run the engine. The dip-rod should be wiped dry before checking the level in the

sump, so that the true level may be seen. The dip-rod is located on the carburettor side of the engine.

Removing Pump

The oil pump is located in the sump, and should the pump require examination, it can be readily removed from the engine by taking off the sump, and removing the two screws which secure it to the bottom flange of the crankcase. The pump can then be drawn downwards and removed as a complete unit. The heads of the screws are drilled and a piece of soft-iron wire is threaded through to lock them. Examine the oil-suction pipe from the sump to the pump, and make certain of an absolutely perfectly tight joint between the flange of the pipe and the pump body, otherwise the pump will tend to draw air at this point instead of oil from the base. Before replacing the oil pump in the crankcase it is advisable to remove the distributor complete, so that re-engagement of the tongue-and-slot connection between the distributor shaft and the pump shaft can be more easily made. When the oil pump is in position, engage the distributor-drive shaft with the top of the pump-driving shaft, then replace the distributor, turning the spindle until it engages with the tongue on the driving shaft. Do not use force when refitting the distributor bracket. When the shafts are engaged correctly, the face of the bracket should seat flat on the cylinder head ; the setscrews may then be tightened up. The ignition must be retimed and, if necessary, the high-tension leads rearranged to obtain the correct firing sequence.

Dismantling and Cleaning Oil Pumps

As a precautionary measure the oil pump should be removed and cleaned at certain fixed periods. Any sludge that is allowed to accumulate on the recessed part of the pump body which enters the crankcase will tend to obstruct the passage of oil through to the engine bearings.

In order to remove the oil-relief valve, first unscrew the plug, then the spring and the sleeve containing the ball may be removed. These and the recess from which the sleeve has been withdrawn should be cleaned. In reassembling the parts observe the following order : Place sleeve in position in the crankcase, then insert the ball, and after that the spring. See that the light spring washer is in place in the screwed plug, and the joint washer is in good condition ; then return the plug to the crankcase and screw tight.

Failure of Oil Pressure

As the lubrication system is automatic, it will be clear that the main point to watch is that the oil-pressure indicator light shines the whole time the engine is running. Should the light fail the engine must be immediately stopped and the cause ascertained. This may generally be attributed to one of the following :

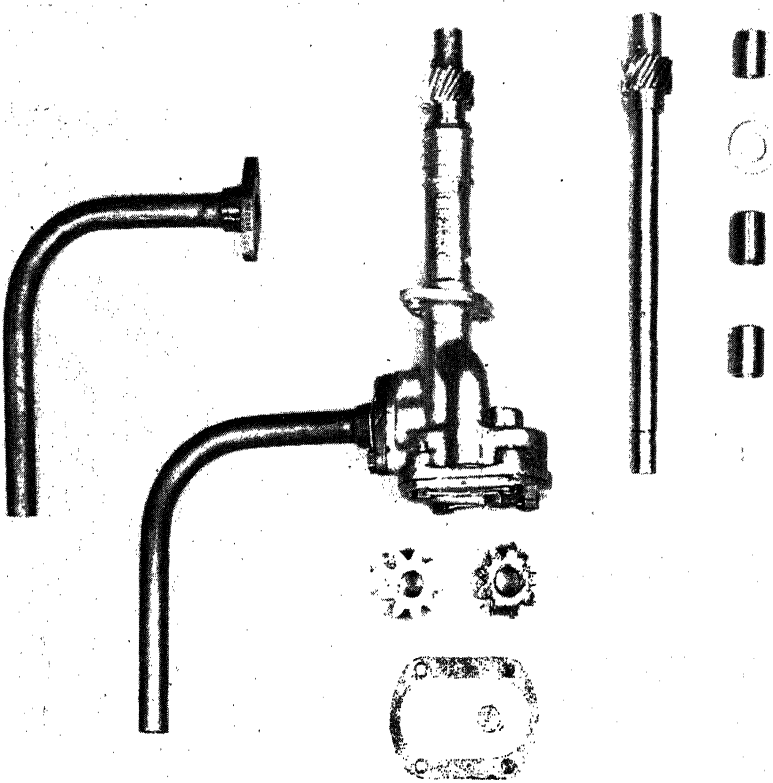


Fig. 6.—THE TC/4-ENGINE OIL PUMP AND DRIVE, WITH PARTS

(1) Not sufficient oil in engine. Check by dip-rod, and fill to correct level if necessary.

(2) Defective indicator light. The light bulb may be burnt out or the wires to the plunger may be chafed or broken. If, after a change of bulb and an examination of the wires, there is still no light, unscrew the oil indicator and press the thumb over the hole while the engine is running. It will soon be felt if there is any pressure in the system.

(3) Worn bearings. In this case too much oil escapes from the main and big-end bearings, resulting in reduced pressure.

(4) Relief valve seating imperfectly. Remove and clean relief-valve spring, ball, and seating. When replacing, be sure to assemble the parts in their correct order.

Cleaning and Removing Sump

Every five thousand miles, or more often if convenient, the oil should be drained from the engine and the sump washed out. Do not use

paraffin unless the sump is removed, as small quantities which collect in the recesses of the crankcase may have a harmful effect on the working parts. Special flushing oils are obtainable for this purpose, and, having some lubricating value, any small quantities left in the crankcase will not injure the engine.

The sump is drained by removing the large plug located at the rear of the sump, underneath the clutch housing. The upper plug is for draining the clutch casing. The best time to drain the sump is after a long run, when the oil is warm and fluid. This makes the draining more complete, as the oil flows so much more freely.

It is advisable to remove the sump periodically and thoroughly wash it out ; the gauze strainer across the top should be thoroughly cleaned and inspected at the same time. To remove the sump take out the set-screws and bolts securing it to the crankcase and gearbox, and lower straight down until the oil-suction pipe is cleared ; it can then be with-drawn in the manner found most convenient.

Oil Specification

The oil to be used in the engine should have the following properties :

Specific Gravity.—This may indicate the origin of the oil, but is not a guide to the quality of the oil, and no figures are given.

Viscosity (Redwood seconds).—This should be in accordance with the following table :

Temperature	*Viscosity*
70° F.	1,800 (max.) Redwood secs.
140° F.	135 to 180 ,, ,,
200° F.	50 to 65 ,, ,,

This specification should be used under all normal conditions, the lower limits being recommended for winter use, short journeys, cold starting, etc. This specification is equivalent to S.A.E. 30.

Flash Point.—This should not be below 360° F. by closed test.

Cold Test.—The oil should be in liquid state at 15° F.

Clutch

A single-plate dry-disc type clutch is used with a graphite-ring type release bearing. The clutch splines and spigot bearing are lubricated by an oil-gun connection, carried in a collar on the clutch shaft, which is reached through the door in the bottom of the clutch compartment ; gear oil (40 strokes of a standard gun) should be injected here every 1,000 miles.

Immediately after the oil has been ejected, slight clutch slip may occur, but this will soon pass off. If, however, it is found to be excessive, the quantity of lubricant should be reduced. The clutch is correctly adjusted by the manufacturer before leaving the works, and 1 in. of free

movement on the pedal (measured at the pedal pad) is allowed before commencing to operate the clutch. This free movement will be gradually reduced as the clutch facings wear, and it is important that this amount of free travel should be periodically restored by adjusting the length of the rod between the pedal and the clutch-operating shaft. The clutch-operating-shaft lever is mounted on its shaft on a multiple spline, so that further adjustment can be obtained by moving the lever round a spline and resetting the length of the rod.

Dismantling Clutch

As the engine and gearbox are of unit construction, the gearbox must be taken off if it is necessary to remove the clutch. To dismantle the clutch from the flywheel, remove the screws holding the cover plate to the flywheel face. Do not disturb the three release-pad screws. Loosen each fixing screw a turn or two at a time until the spring pressure is relieved. All the screws can then be removed and the complete clutch lifted off the flywheel, all parts except the driven plate being assembled to the cover. When replacing the driven plate in the flywheel be sure that the chamfered end of the splines in the hub is toward the gearbox. When reassembling the clutch it is essential that the release-lever plate should be absolutely parallel with the pressure-plate face. This is attained by either reversing the side of the release pad or by packing it with shims. This operation is best checked on a surface-plate or in position on the flywheel. If these faces do not run true, uneven engagement and wear on the linings and withdrawal mechanism will all take place.

Gearbox and Change-speed Gear

The gearbox is bolted to the clutch housing, and the latter is spigoted directly to the crankcase ; provision is made for fitting a tyre pump or power take-off, if required. The speedometer is driven by spiral gears incorporated at the rear of the mainshaft.

The selector mechanism is carried in a separate cover, and can be removed as a complete unit. The position of the change-speed lever in the various gears is clearly shown on the change-speed gate, and to engage reverse gear the trigger on the lever must be lifted to clear the reverse stop before it can be moved into the reverse position.

Fill with gear oil to the test-plug level, and top up at intervals of five thousand miles.

It is advisable to drain and thoroughly wash out the gearbox every twenty thousand miles, or more often if convenient, so that any pieces of foreign matter which have accumulated will be prevented from doing damage by getting into the bearings. This should preferably be done immediately after a run, as the oil will then be warm, and will flow more freely through the drain-plug hole.

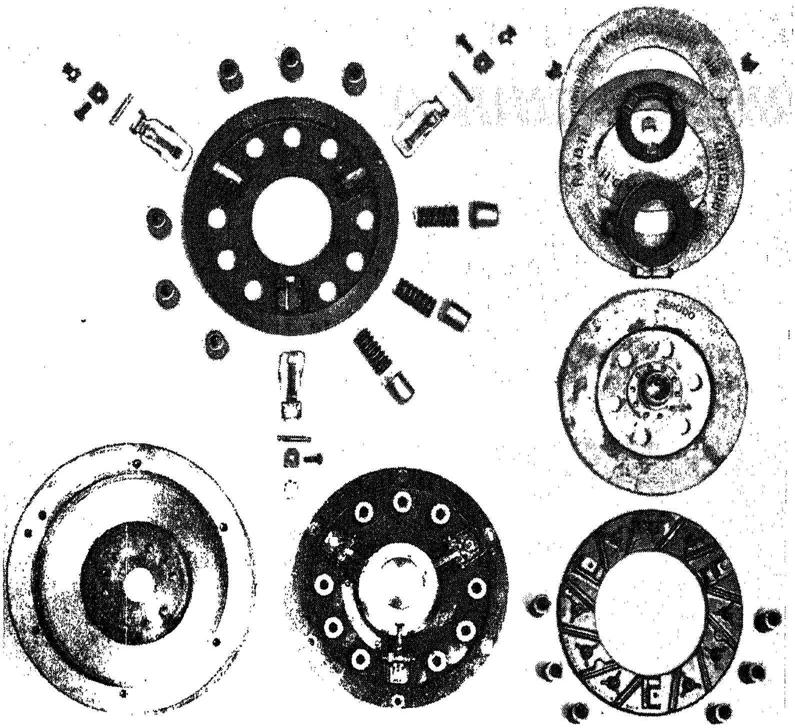


Fig. 7.—TC/4 FLYWHEEL AND CLUTCH ASSEMBLY, WITH ALL PARTS SHOWN IN RELATIVE POSITIONS

Dismantling Gearbox

Given sufficient lubrication and care in gear-changing, little attention will be required over long periods. Should it be necessary, however, to dismantle the gears and shafts, the complete box must first be removed from the chassis, an operation which can be carried out without disturbing the engine. The method of removal will depend upon the facilities available. The box will have to be lowered to the ground after being detached from the engine, and the following method will give an idea of the procedure.

Uncouple the universal joint behind the gearbox and on the rear-axle worm-shaft, unbolt the intermediate shaft bearing bracket from the frame cross-member, and slide the shaft backwards.

Uncouple the speedometer-drive cable from the rear of the gearbox, also the tyre-pump connections, if fitted, and remove the vacuum pipe from the servo cylinder.

Disconnect the clutch-pedal link and take off the change-speed gear

by unscrewing the four setscrews securing it to the gearbox. The removal of the change-speed gear on the forward-control model will be greatly facilitated if the two small bolts securing the rear cowling to the inner footboard support are removed. This allows that part of the cowling to be eased up when lifting out the change-speed housing.

When the cover carrying the selector mechanism is taken off, place a piece of cardboard over the top of the gearbox, to prevent dirt, etc., falling inside.

Arrange some form of support for the gearbox and take off the nuts securing the box to the crankcase; then, using extractor screws in the tapped holes provided in the flange of the bell housing, push the box off its spigot and disengage the clutch shaft from the clutch centre. The box can then be lowered to the floor.

To remove the mainshaft and gears, draw off the propeller-shaft coupling and take off the side cover, if this has not already been done, and the speedometer-drive casing. The shaft can then be extracted, the gears being left behind in the box in the process; distance-pieces between the gears are helpful if available, but are not necessary.

The constant-running pinion can then be withdrawn through the front end of the box, when the nuts securing the bearing housing are undone.

To remove the layshaft, the bell housing must first be detached from the gearbox. The nut and washer on the front end of the shaft should then be taken off, and the rear bearing driven out of its housing by giving the forward end of the shaft a few blows with a hammer. Use a lead hammer or a block of wood to avoid damaging the thread on the end of the shaft. The layshaft will, at the same time, be knocked free of the front bearing. Draw off the rear bearing, pull out the shaft, and remove the gears through the side of the box.

The reverse pinion shaft is secured by a locking pin which passes through the shaft and its inner bearing lug. To remove the reverse pinion, unscrew this pin and draw the shaft out by means of a $\frac{1}{2}$-in. B.S.F. bolt screwed into the end of the shaft.

Special extractors for dismantling the gearbox can be obtained from any of the manufacturers' branches.

When replacing the gearbox, raise it to approximately the correct height, and engage the splines on the constant-running shaft with the clutch plate centre, and slide the box forward. If the spigot on the front end of the shaft does not match up at once with the bearing in the flywheel, be patient and handle the box gently. Any violent wrenching will result only in distortion of the clutch plate and mal-alignment of the constant-running shaft.

On the forward-control chassis the change-speed lever is ball-mounted, the spherical end pivoting in a hardened steel thimble. Oil should be given to the ball end and to the change-speed shaft connection occasionally with an oil-can.

Removing Engine from Chassis

Should it be found necessary to remove the engine and gearbox from the chassis, we suggest the following procedure :

(1) For the forward-control model remove right-side bonnet panel and rear cowling, and on normal-control remove bonnet. On both models drain water from radiator and cylinder block, take away footplates, disconnect ignition-coil and water connections, then remove radiator.

(2) Uncouple the gearbox at the rear end from the propeller shaft or intermediate shaft (if fitted). Remove change-speed lever from gearbox cover on normal-control types only.

(3) Disconnect the speedometer drive, petrol pipe, carburettor and accelerator controls. Disconnect the leads from the battery (to avoid shorting), and then from the dynamo and from starter (if fitted). If a tyre pump is fitted, remove handle and disconnect pipe to filter.

(4) Uncouple the exhaust pipe from the exhaust manifold.

(5) Sling the engine by means of strong wire slings. The approximate weight of the complete engine and gearbox is 8 cwt., and lifting-tackle easily capable of taking this load must be used. Take the strain of the engine by the lifting tackle.

(6) Remove the bolts holding the front supporting bracket on engine. Remove eight bolts holding the front cross-member and three bolts from left-side front spring bracket, this will also release the stiffener-plate behind this bracket. The front cross-member can then be withdrawn from the frame, moving this forward at the left side and to the rear at the right side. Remove the four set-bolts from each of the two rear supporting brackets on engine ; the engine can then be drawn forward out of the frame.

In order to facilitate the removal of the power unit from the forward-control chassis, Messrs. Thornycroft have devised a particularly interesting type of trolley. This trolley consists of an angle-iron framework, about 5 ft. by 2 ft., which is carried on four small wheels about 6 in. in diameter ; at either end of the trolley there is a lifting-jack. When the radiator and bonnet, etc., have been removed, the trolley is inserted underneath the power unit, and to do this it is necessary to temporarily remove the rear jack to allow the trolley to pass under the front axle. The rear jack should then be fitted and the jacks screwed up until they have taken the weight of the power unit, the rear jack bearing on the shank of the companion flange on the rear of the gearbox, and the front jack bearing upon the starting-handle bracket. All the engine suspension bolts, transmission, etc., can then be uncoupled, and the power unit can be brought forward until the rear jack fouls the front-axle body. The power unit is then sufficiently forward to allow a pulley block and sling to be used on it, and the trolley is no longer necessary.

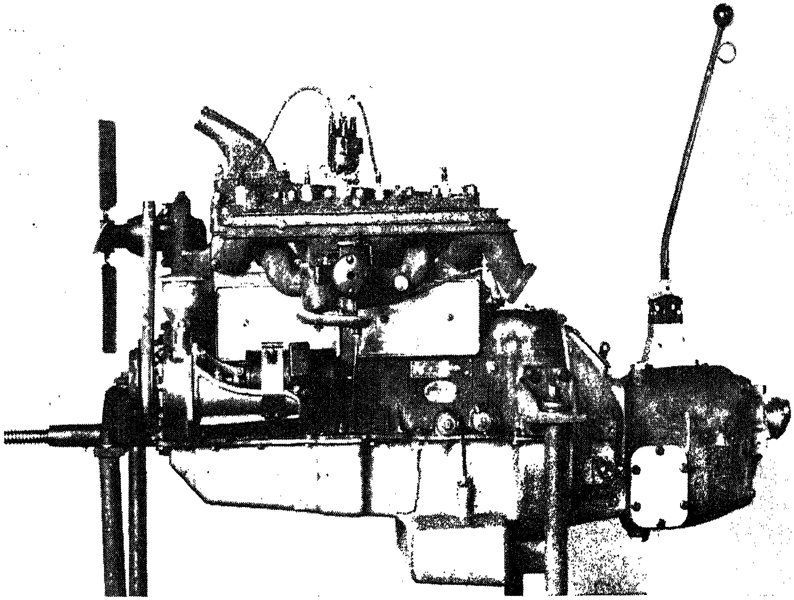


Fig. 8.—TC/4 POWER UNIT WITH NORMAL-CONTROL CHANGE-SPEED GEAR

Starting

To facilitate starting, an easy-starting device is incorporated in the carburettor. It should be appreciated that the accelerator pedal should be in the closed position when using this starting-device. This is necessary to produce sufficient suction on the starting-jet.

The starting-device is operated by a control knob on the engine bonnet, and this should be pulled out to its maximum travel. The engine can then be started. Under extremely cold or other unfavourable conditions the engine may stop, and it may be necessary to restart once or twice before the engine continues to run.

The starting-device should be left in operation, and the engine allowed to run on this for several minutes, but not long enough to cause irregular running, which will be very liable to soot up the sparking plugs.

If the engine does not start in a normal way it may be due to some defect in the ignition, and sparking plugs should be examined.

In attempting to start with defective ignition, the mixture may become too rich, and the engine will not start. It will then be necessary to open the throttle and turn the engine several times to clear out the over-rich mixture before attempting to restart to the instructions set out above. The starting-device control should never be left in the half-way position, and the vehicle should never be driven with the starting-device in operation.

THE MORRIS TEN ENGINE AND GEARBOX

SERIES M

Dismantling for Decarbonising and Valve Grinding

DRAIN the radiator and cylinder block of water. Remove the bonnet. Additional freedom of movement is obtained by removing the radiator tie-bars, although this is not absolutely essential.

The flexible petrol pipe should be disconnected from the petrol pump, and the mixture and throttle controls released from the carburettor. The air cleaner and silencer should also be detached from the carburettor. Remove the carburettor and the manifold. Disconnect the water-outlet flange from the cylinder head.

The oil-feed pipe to the cylinder head should also be released by undoing the union bolt of the banjo connection, taking care not to loose the copper-asbestos washers which are located on either side of the banjo to ensure an oil-tight joint. The oil pipe, when released, should be bent outwards to clear the cylinder head, in order to avoid subsequent accidental damage.

The cylinder-head cover can now be removed. This will reveal the valve-rocker assembly, which should be removed after carefully unscrewing the bolts to avoid bending the rocker shaft. Now remove the push-rods and cylinder head.

The valve mechanism follows orthodox practice, except that the valve heads are plain. A suction-type valve-grinding tool is therefore necessary, and a suitable tool is marketed by the manufacturers under Part No. 66893.

In accordance with Morris practice for a number of years, the valves are numbered on their heads to correspond with their parts, No. 1 valve being at the forward end of the head. It is of importance always to retain the valves in the same ports, and any new valves introduced should be numbered to ensure their subsequent correct replacement.

Before removing the valves the sparking plugs should be removed and put in a place of safety.

A wooden block should be prepared to fit loosely in the combustion space, and it should be slightly thicker than the depth of the combustion space so that it rests firmly against the valve heads. If you are dealing with an appreciable quantity of this work, it may be worth your while to make a number of these blocks and fasten them down on a board at the correct intervals, so that all four combustion spaces are filled at once.

With the head resting on the wood block the valve springs can be compressed, with the help of a slotted-tube compressing tool, while the cotters are withdrawn from the valve stem. Morris Motors have available a bench-type compressing tool which is obtainable from their service parts department at Cowley. Its part number is 67456.

When the cotters, spring caps, oil shields, springs, rubber sealing rings, and valves are all removed, the carbon deposit should be removed from the surface of the combustion spaces and the valve ports, the cylinder head being then thoroughly washed in clean paraffin and dried.

Valves, valve seatings, and valve guides should now carefully be examined for pitting or wear, and any defective valves or guides replaced.

Defective seatings should be trued up with a proper reseating tool to avoid unnecessary grinding-in of the valves. It should be noted that the valve seating angle is 30°, and that the inlet valves are not the same size as the exhaust valves, the exhaust valves being the smaller.

Special valve-seating cutters are obtainable from Morris Motors Limited, under Part No. 67815 for the inlet valves and Part No. 67816 for the exhaust valves, and use of these is recommended.

The valve guides are a tight push-fit in the cylinder head and have no shoulder for location. When valve guides are renewed, it is therefore important to see that the guides are pushed into their correct position in line with the other guides.

When grinding is complete and all components are thoroughly clean, reassemble, taking care to replace the rubber sealing rings in the valve-stem grooves just below the cotters, in order to prevent the passage of oil down the valve guides. It is to be noted that these rings are of special oil-resisting rubber.

When the head is completely reconditioned, attention may be given to the cylinder block.

Before replacing the cylinder head, examine carefully the gasket, and make sure that it is in good condition. If it is damaged in any way, it should be replaced by a new one. New gaskets need no jointing compound, but the use of a little gold size or similar jointing material is permissible in the case of old gaskets.

Replacing Cylinder Head

Owing to the absence of studs for fixing the cylinder head, it is advisable to employ two temporary studs, approximately 6 in. long and screwed into opposite corners of the cylinder block, to guide the head into position on replacement until a sufficient number of the cylinder-head bolts have been introduced.

When replacing the gasket, take care to see that it is replaced the right way round with the end opening for the water duct coinciding with the end port in the cylinder block.

When the head is firmly bolted down, the push-rods can be refitted,

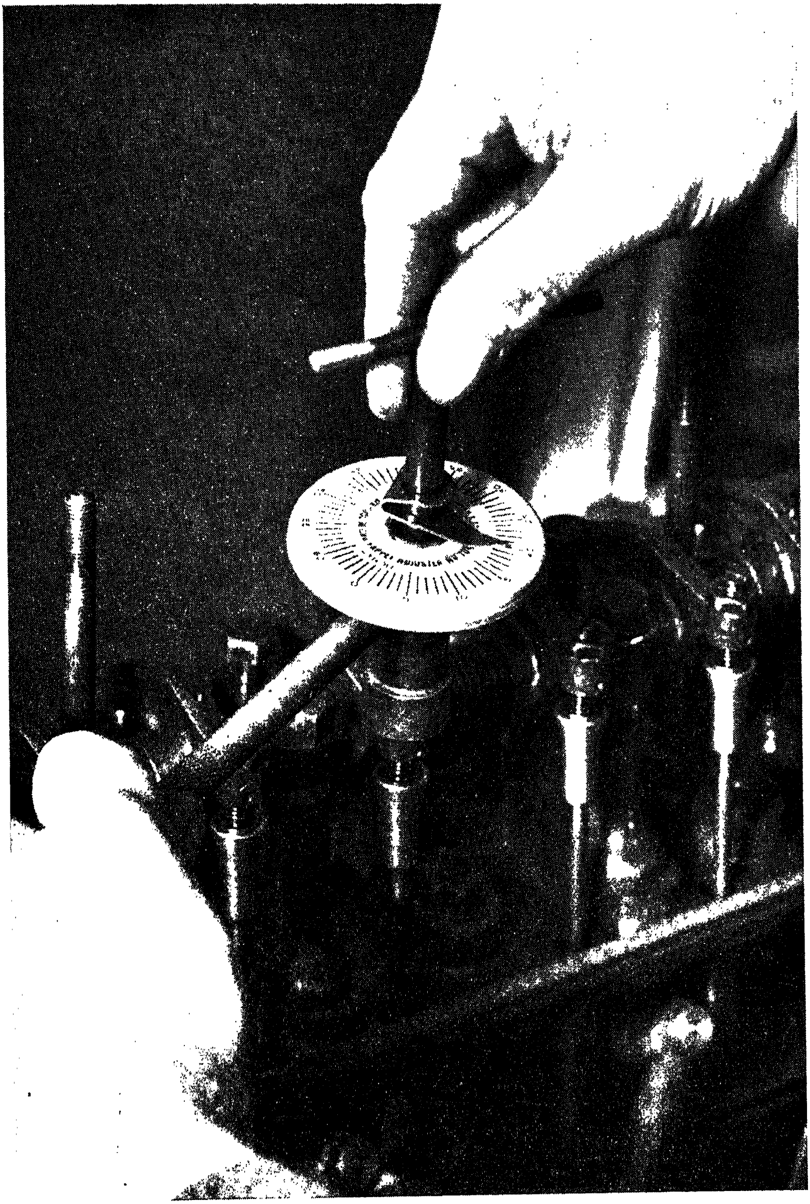


Fig. 1.—THE SPECIAL MORRIS VALVE-SETTING TOOL IN USE

This tool enables the valve clearances to be set rapidly and with the greatest simplicity.

making sure that the ball at the lower end of the push-rods is in proper engagement with the socket on the tappet. The rocker-shaft assembly can then be replaced and bolted into position again, taking care to tighten up the retaining bolts gradually to avoid straining the rocker shaft.

Adjustment of the tappets is then carried out by releasing the adjusting-screw locknut and setting the clearance to ·019 in. between the rocker head and the end of the valve stem, when the tappet is exactly at the back of the cam. Owing to the special cam contour employed on this engine, this latter point is essential, and can easily be ensured by adjusting the valves in the following sequence.

Adjust	No.	1	rocker	with	valve	No.	8	fully	open.
,,	,,	3	,,	,,	,,	,,	6	,,	,,
,,	,,	5	,,	,,	,,	,,	4	,,	,,
,,	,,	2	,,	,,	,,	,,	7	,,	,,
,,	,,	8	,,	,,	,,	,,	1	,,	,,
,,	,,	6	,,	,,	,,	,,	3	,,	,,
,,	,,	4	,,	,,	,,	,,	5	,,	,,
,,	,,	7	,,	,,	,,	,,	2	,,	,,

Special Tappet-adjusting Tool

A special adjusting tool has been devised by the makers to facilitate valve adjustment, the body of which is adapted to engage the rocker-screw locknut, while the centre spindle engages the slot in the screw. A dial marked with divisions equivalent to ·001 in. enables the adjusting screws to be turned back from the no-clearance position until the required clearance is indicated, with an allowance of ·002 in. for the tightening effect of the locknut. The locknut is then firmly tightened up and the setting tool removed.

The remaining parts are replaced in the reverse order to their removal and present no special difficulty, but when the engine has been run for some fifteen minutes the valve cover should be removed, the cylinder-head bolts carefully tightened up, and the valve clearance reset.

Removal of the Power Unit from the Car

Owing to the monopiece type of construction employed in this Morris Model, certain differences of procedure are entailed when dealing with the removal of the power unit as compared with the orthodox type of construction.

While the water from the cooling system is draining away, remove the bonnet. Disconnect the battery positive cable. Remove the detachable bonnet sides. Release the radiator tie-rods.

Release the hose clips on the top and bottom radiator hoses, and free the hoses from their connections.

Disconnect the radiator shell by unscrewing the four setscrews on each side which attach the wing valance to the radiator shell, and the two round-headed screws which attach the apron to the bottom of the shell.

The radiator core should be released by unscrewing the retaining nuts screwed on to the radiator attachment studs under the front cross-member. This will enable the radiator to be removed.

Release the exhaust pipe from the engine manifold. Disconnect the mixture and throttle controls from the carburettor, and the flexible petrol pipe from the feed pipe of the petrol pump at the junction union. Release the starter cable and high-tension lead from the coil, and the distributor and dynamo leads ; the green dynamo lead is attached to the top terminal. Remove the air cleaner complete with intake pipe. Release the fume exhaust pipe from the clutch housing by withdrawing the bolt which fastens its bracket, and release it from the tappet cover by slackening the pinch-bolt of its attachment clip. This enables you to remove the pipe.

Disconnect the oil-gauge pipe from its attachment to the cylinder block.

Slacken the locknut below the gear-lever knob, and unscrew the knob and locknut from the gear-lever end. This will permit you to pass the gearbox rubber cover over the gear lever and remove it.

The gearbox inspection cover should now be removed. This will give access to the forward universal joint flange, which should be parted by removing the four split-pinned bolts and nuts joining the two flanges together.

The gearbox cover, complete with gear lever, may now be removed by unscrewing the six retaining nuts, taking care not to lose the three selector ball springs at the rear. The three selector locking balls in the rear wall of the gearbox should also be withdrawn, for safety, by lifting them out of their housings with thick grease on the end of a pencil or similar article.

A temporary protecting cover of card or thin metal should now be placed over the gearbox opening to prevent the entry of dirt or other articles into the box.

The speedometer cable should now be disconnected from the gearbox drive, and the clutch-actuating chain should be released from the clutch pedal by withdrawing the connecting clevis pin.

Supporting Engine

At this stage it is necessary to support the engine on suitable lifting tackle, using some 15 ft. of rope or wire cable looped under the clutch housing, just behind the drainage hole with split-pin, and under the front end of the crankcase sump, just behind the front engine-bearer plate. When taking the weight of the engine, take care not to damage any of the components, in particular such items as oil pipes and the distributor.

The bolts which attach the front engine-bearer plate to the flexible mountings on each side should now be removed, and the four bolts and two setscrews which attach the gearbox supporting yoke to the underside of the body at the rear end of the unit.

This completely releases the engine, which can now be lifted with the

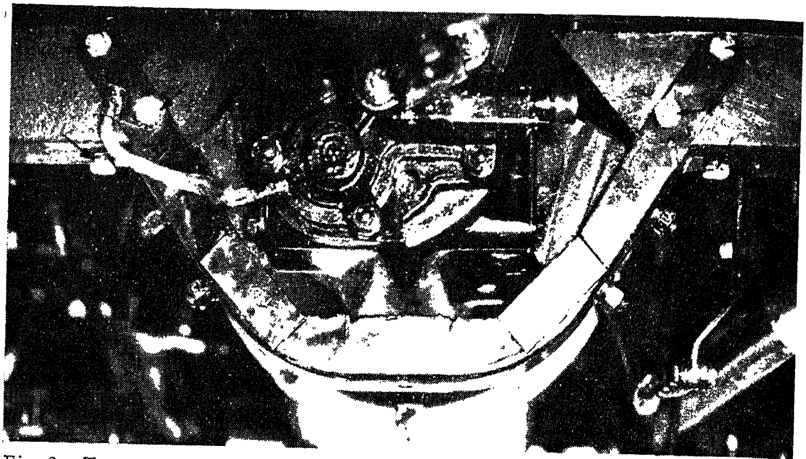


Fig. 2.—THE YOKE SUPPORTING THE REAR END OF THE POWER UNIT IS HERE SHOWN TOGETHER WITH THE SIX BOLTS WHICH ATTACH IT TO THE UNDERSIDE OF THE BODY STRUCTURE

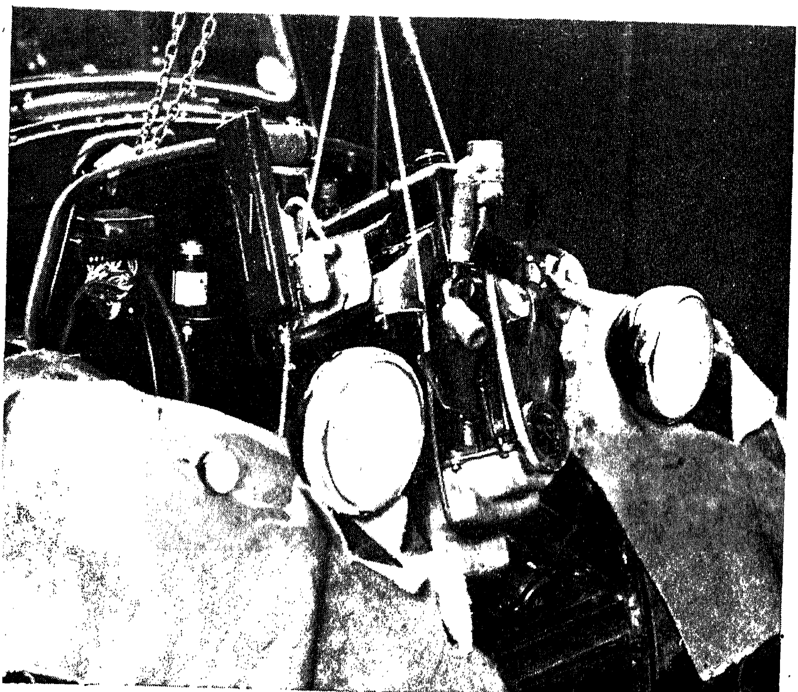


Fig. 3.—REMOVAL OF POWER UNIT

When all the necessary connections have been freed the engine unit is withdrawn in an upward and forward direction as shown.

raising tackle, taking care to see that it is not fouling anywhere. It will be found best to allow the rear end of the unit to drop sufficiently to clear the car floor and the scuttle opening, and carefully raise the unit in a forward and upward direction until clear.

When the engine unit is replaced at a subsequent period, it is advisable to locate the forward bearer plate of the engine to the flexible mountings with one bolt on each side, while the rear end of the unit is raised into position. If trouble is experienced in raising the rear end by means of the sling, a jack may be used under the gearbox in order to lift it into position so that the supporting yoke can be coupled up. Before introducing the gearbox supporting-yoke attachment bolts it is of advantage to line up one of the holes with a suitable tapered mandrel, to facilitate the location of the remaining holes and the insertion of the bolts, which have tapered ends to further facilitate their insertion.

Avoid using unnecessary force when replacing the bolts, or you will damage their threads.

When the four bolts passing through the frame cross-member have been fitted, the two setscrews attaching the yoke member to the underside may be refitted.

The remainder of the components are refitted in the inverse order to their removal, and do not call for any special mention.

Dismantling the Engine Unit

The gearbox is removed from the engine by removing the series of ten attachment bolts which locate the clutch housing to the flywheel housing, and releasing the pull-off spring from the clutch-operating lever, enabling the gearbox to be withdrawn rearwards.

The carburettor is removed from the manifold by undoing its two attachment nuts, while the manifold itself is removed by releasing the four yokes from the retaining studs.

The valve cover is, of course, removed by undoing the two knurled hand nuts, and the head is removed and dismantled in the manner described in the paragraph on decarbonising.

The dynamo is released by undoing the three attachment bolts, the upper one of which should first be released to allow the fan belt to be removed from the pulley. The sump is attached to the lower face of the cylinder block casting by fourteen setscrews, and to the forward face of the flywheel housing at the rear by five setscrews.

Removal of these setscrews enables it to be withdrawn complete with the oil-pump intake assembly, which is bolted to the side of the sump.

The timing-case cover is attached to the forward face of the cylinder block by a series of setscrews, and is easily removed after the crankshaft fan pulley has been withdrawn. The latter is keyed to the crankshaft and retained in position by the claw nut for the starting-handle, as in normal Morris practice.

The timing chain is removed when required by releasing the retaining nut from the end of the camshaft, after bending back the tab of its locking washer, and carefully levering the camshaft and crankshaft sprockets away from the engine, with the chain in position on the sprockets. Care should be taken during this operation not to damage either the chain or the sprockets.

The distributor, oil pump, and tappets have to be withdrawn in order to release the camshaft, which is in addition located by a keep plate, between the sprocket and the front bearing, which is attached to the forward face of the cylinder block.

The distributor is released by withdrawing the setscrew which locates the pinch-plate to the distributor-housing bars on the side of the cylinder block. Removal of this setscrew enables the distributor to be withdrawn from the tunnel without difficulty.

It should be noted that it is unwise to disturb the pinch-bolt itself or the timing will be lost, necessitating complete retiming.

The oil pump is released by disconnecting the external oil pipe from the pump body and undoing the series of setscrews passing right through the pump and locating it to its housing in the side of the crankcase, enabling it to be withdrawn. Note that the four long bolts pass through the pump covers.

The tappets are withdrawn after releasing the rocker-shaft assembly, removing the push-rods, and detaching the tappet-chamber cover plate.

The rocker-shaft assembly is released by undoing the eight rocker-shaft bracket fixing bolts, after tapping back their locking washers and carefully unscrewing the bolts to avoid the possibility of bending the rocker shaft.

Removal of the rocker shaft permits the push-rods to be withdrawn without difficulty, and the tappets themselves can be withdrawn with equal ease once the tappet-chamber cover plate has been removed.

Removal of the camshaft keep plate from the front face of the cylinder block, and the dowel screw of the centre bearing, now permits the complete removal of the camshaft, care being taken to catch the split centre bearing as it is withdrawn.

The cylinder head is easily removed by undoing the series of bolts attaching it to the cylinder block, remembering that it is advisable to release these bolts gradually half a turn at a time in the order of rotation usually followed, in order to prevent undue bending loads on the cylinder head, which might lead to its permanent distortion.

The piston and connecting-rod assemblies are released by undoing the clamp-bolts of the big ends, and they can then be withdrawn downwards through the crankcase without much difficulty, particularly if the crankshaft is turned carefully to give the maximum amount of room.

In common with other Morris engines, the pistons float on the gudgeon pins, which are rigidly clamped to the split little end of the connecting

rod. It is essential, therefore, that the piston shall not be held in a vice except by means of shouldered plugs inserted in the ends of the gudgeon pins.

When unscrewing or tightening up the clamp-screws of the little end it is unwise to use too much force. The pressure obtainable with a tommy-bar 6 in. long is ample for this purpose.

When reassembling the engine, care should be taken to see that the centre bearing of the camshaft is correctly replaced, with its dowel hole coinciding with the hole for the dowel screw. Two holes are provided in the side of the bearing to enable it to be rotated into the desired position by means of a pin spanner.

The camshaft timing is easily regained by ensuring that the bright links on the camshaft chain coincide with the sprocket teeth marked with a "T."

This is facilitated by turning both the crankshaft and camshaft so that their keyways are in the top-dead-centre positions, and assembling the chain on the sprockets with the marked tooth on the crankshaft sprocket at bottom dead centre, that on the camshaft sprocket at top dead centre approximately. This is carried out quite easily if the chain is doubled with the bright links lying next to each other, and then placed on the sprockets with the longer run of the chain on the right, i.e. on the same side as the camshaft sprocket.

When the chain is properly assembled on the sprockets there should be no difficulty in picking up the keyways on the camshaft and crankshaft, when the assembly is replaced on the shafts.

Do not forget to bend back the edge of the camshaft-retaining-bolt lock washer before replacing the timing cover.

When replacing the piston and connecting-rod assemblies, make sure that they are replaced the right way round with the pinch-bolt on the offside of the engine.

Before replacing the sump make sure that the oil-seal ring in the rear main-bearing cap is in good condition and free from distortion, and make sure also that the semicircular oil seal at the forward end of the sump is in sound condition.

When the distributor is replaced it should be remembered that it must be fitted in the correct position, in order to obtain the correct timing.

To ensure this, turn the engine until No. 1 piston is at the top-dead-centre position on the firing stroke, i.e. with the exhaust valve of No. 4 cylinder just closing and the inlet valve just opening. Hold the distributor in the position in which you would offer it up to its housing, and turn the spindle until the central rotating arm points to the twelve o'clock position. Carefully insert the distributor into its housing, and as the gears engage the rotor will be moved round to the two o'clock position, giving the correct timing position.

A final check on the correct ignition timing can be made by observing

that the distributor points are just opening when the indicating arrow on the fan pulley is 11 mm. before the pointer on the timing-chain cover.

Removal of the Water Pump

Drain the radiator by opening the taps provided in the radiator bottom tank and on the offside of the cylinder block.

Slacken the dynamo attachment bolts, thus releasing the fan-belt tension and enabling the belt to be withdrawn from the pump pulley.

Remove the fan blades from the fan hub by unscrewing the four setscrews and spring washers.

Slacken off the clips of the water pump and radiator bottom hose, and release the hoses from their connections.

Remove the two setscrews on the nearside and the two nuts on the offside of the pump-body flange.

Move the dynamo away from the engine as far as it will go, removing the setscrew locating the dynamo and adjusting bracket to the cylinder block.

This will enable you to withdraw the pump forward until clear of the block, and remove it from the nearside of the engine.

Dismantling the Water Pump

The water pump is of the impeller type, utilising a spring-loaded carbon disc as a water seal.

When the pump is dismantled, care should be taken to note the correct location of the parts for reassembly.

It is first necessary to remove the hexagon nut from the forward end of the shaft after extracting its retaining split-pin. Do not lose the flat washer found under the nut.

Withdraw the fan pulley from the pump spindle, and extract the Woodruff driving key. Remove the felt washer and dished washer immediately behind the fan pulley.

The impeller is attached to the shaft by a taper pin, which should be carefully tapped out to release the impeller, taking care to collect the coil spring, brass washer, rubber washer, carbon disc, and the carbon-disc locating pin.

The forward bearing is located in the pump body by two circlips, one on each side of the bearing.

To release the bearing, remove the front circlip and gently tap the pump spindle forward until a suitable extractor can be applied to withdraw the bearing from the shaft.

Further dismantling is carried out by extracting the second circlip and withdrawing the bearing spacer which is located on the spindle.

This will permit the rear bearing, complete with the shaft, dished washer, felt washer, plain steel washer, and retaining circlip, to be withdrawn from the pump body as an assembly.

The carbon sealing gland is intended to run dry, and lubricating oil of

any kind must be kept away from it. In cases where chatter or a squeak develops it may be cured by introducing a few drops of Lockheed brake fluid on the pump spindle just behind the pulley, which will penetrate to the sealing faces and release the trouble.

Removal of the Gearbox

The gearbox can be removed from the car without disturbing the engine, provided suitable lifting tackle is available to support the rear end of the engine during the operation.

First of all remove the bonnet in the manner already described in the paragraph on decarbonising; as a safety measure, disconnect the battery positive lead from the battery terminal post.

Detach the fume exhaust pipe from the nearside of the unit by removing the clutch-housing bolt which secures the lower end of the pipe, and releasing the pinch-bolt which locates it to the pipe on the tappet cover.

Slacken the locknut beneath the gear-lever knob and unscrew the knob. This will enable you to withdraw the rubber gearbox cover, giving access to the gearbox inspection cover, which can be removed by unscrewing the ten countersunk screws which retain it in position.

Withdraw the split-pins from the four bolts of the universal joint flange, and unscrew the nuts.

Unscrew also the six gearbox-cover retaining nuts and remove the cover, taking care not to lose the three springs for the selector locking balls which are located at the rear end of the box. When the gearbox cover is removed, the top of the box should be protected with a temporary sheet-metal-on-cardboard cover, after extracting the three locking balls from the rear wall at the box.

Release the speedometer cable from its attachment at the rear of the gearbox, and remove the clevis pin from the yoke which connects the clutch actuating chain to the clutch pedal.

Place a jack under the rear end of the gearbox, or support the box on a suitable wood trestle.

A stout bar should now be placed across the car floor immediately over the centre of the box; lash the gearbox to this with a rope sling so that it is safely supported.

Place another rope sling under the rear end of the engine at the flywheel housing, and take the weight of the engine unit on this with suitable lifting tackle.

The gearbox suspension yoke may now be released from the underside of the car by removing the four bolts which connect the yoke and the frame member, and the two setscrews which screw into the cross-member.

Carefully lower the jack under the gearbox, and lower the lifting tackle, supporting the engine until the rear end of the unit has dropped sufficiently to give access to the upper bolts attaching the clutch housing to the engine-flywheel housing.

Disconnect the clutch pull-off spring from the clutch-operating lever, and remove the ten bolts round the clutch housing which attach it to the engine.

This will enable you to withdraw the gearbox from the engine unit in a rearward direction, finally removing it from underneath the car.

On refitting the gearbox it is wise to check up the alignment of the clutch with the special clutch-aligning tool provided by the makers, and which can be obtained from their spare parts department under Part No. 67833.

When replacing the box it is advisable to again make use of the rope sling and bar, while, in addition, supporting the box with the jack as on dismantling, as the latter will be found useful for raising the power unit in position while the supporting yoke is replaced.

Dismantling the Gearbox

When the gearbox has been removed from the car it is best to hold it in a vice by means of a short length of $1\frac{1}{2}$-in. square bar, turned down at one end and threaded for a short distance, 30-mm. diameter and 2-mm. pitch, screwed into the drain-plug hole.

With the gearbox thus firmly held, the clutch housing may be released from the box by undoing the eight bolts attaching it to the forward face of the gearbox.

The driving flange at the rear end of the gearbox should now be removed after unscrewing the hexagon retaining nut from the end of the shaft. A suitable extractor is needed to withdraw the flange.

Release the speedometer housing from the rear of the box by unscrewing the nuts from the six retaining studs. Withdraw the housing, taking note that there is a plain and a convex washer in the register for journal bearing, the convex washer being fitted into the register first with its convex side outwards. Note, also, that there is a paper washer between the joint faces of the housing, and take care it is not damaged.

Remove the locking wires passing through the heads of the bolts locating the selector forks and stops on the selector shafts. This enables you to unscrew the bolts and withdraw the shafts one at a time, taking care not to lose the locking balls and interlocking plunger.

Remove, from the rear end of the box, the setscrew which locates the layshaft spindle in the box, and with a suitable copper drift gently tap out the spindle in a rearward direction. This allows the layshaft to drop into the bottom of the box.

The drive gear, together with its journal bearing, is now removed by tapping the secondary shaft in a forward direction with a suitable drift.

When the drive gear and its bearing have been dislodged from the front wall of the gearbox, the secondary shaft, together with its associated gears, can be withdrawn in an upward and forward direction through the top of the box after the rear ball race has been extracted from the rear wall of the box by a suitable extractor or by gentle tapping with a drift.

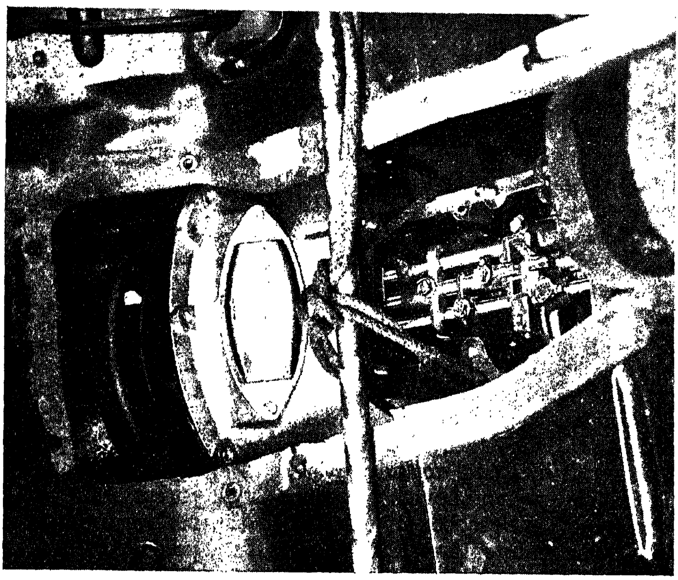


Fig. 4.—HOW THE GEARBOX OF THE MORRIS TEN (SERIES "M") SHOULD BE SUPPORTED DURING REMOVAL AND REPLACEMENT

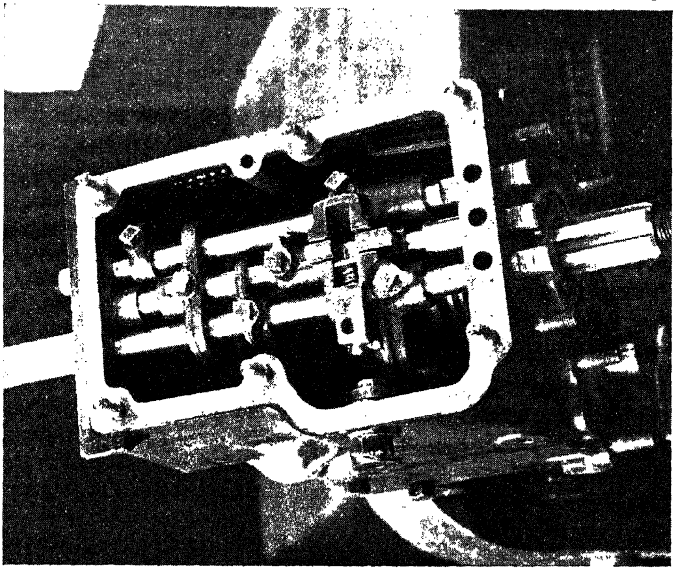


Fig. 5.—THIS ILLUSTRATION INDICATES CLEARLY THE CORRECT POSITION OF THE VARIOUS SELECTORS AND STOPS OF THE GEARBOX

This now gives access to the layshaft in the bottom of the box, which is readily removed. It should, however, be noted that the tabs of the thrust-pads at each end line up with the slots on the bosses in the front and rear walls of the box.

To withdraw the gears from the secondary shaft, first withdraw the top- and third-gear synchromesh hub from the forward end of the shaft, making a note that the plain side of the hub must be assembled towards the rear of the box on reassembly.

Now remove the collar of the third-speed gear by depressing the spring-loaded locking plunger and rotating the collar until the splines are in register with those of the shaft, so that it can be withdrawn.

The third gear may now be withdrawn, but care must be taken that the plunger with its spring and the thirty-two needle bearings are not lost in the process. To avoid this, it is a good plan to wrap the assembly in a duster while the separation is effected.

The circlip at the rear end of the shaft should now be extracted, thus allowing the synchromesh hub of the first and second gears to be withdrawn from the shaft. When withdrawing this hub note that its plain side faces towards the front of the gearbox, and that it must therefore be replaced this way on re-erection.

Removal of the second gear from the shaft is carried out in an exactly similar way to removal of the third gear, again taking care not to lose the plunger with its spring nor the twenty-eight needle-bearing rollers.

It should also be noted at this stage that there is a thrust-washer, next to the second-gear collar, which is in two halves.

Should it be necessary to separate either of the synchomesh hubs, it must be remembered that there are six locating balls and springs which locate the striking dogs to the hubs, and that these will fly out if no precautions are taken. It is therefore again advisable to wrap up these components in a duster while separation takes place.

On replacement, some difficulty may be experienced in replacing the springs and balls, and the method advised is to sharpen a number of short lengths of broken hacksaw blades to a point ; these can be used to retain the balls and springs in position on assembly (*see* Fig. 24, p. 466).

The method of employing these short pieces of hacksaw is to place the striking dog in position on the hub, the two resting on the bench with the ball housings exposed, so that the springs and balls can be inserted. Each spring and ball is then introduced into its housing and retained in position by pushing the pointed end of one of the hacksaw strips between the dog and the hub to hold it in place. When all balls are thus retained in position. the dog can be raised into its working position, carrying with it the retaining blades, which can be removed as soon as the dog is correctly located.

Reassembly of the gearbox is effected in the reverse order to its dismantling, and presents no special difficulty if the points raised during the dismantling instructions are remembered and acted upon.

THE DAIMLER LIGHT STRAIGHT EIGHT

(3½ LITRE)

By A. SQUILLARIO

INTRODUCED in 1935, this model has an 8-cylinder-in-line engine; 72-mm. by 105-mm. bore and stroke give a capacity of 3,421 c.c. R.A.C. rating 25·72 h.p. Brief description of details of the chassis are as follows:

Engine

Overhead valve, push-rod operated. Cylinder head and block cast in one, necessitating removal of block for decarbonising. Five-bearing crankshaft of very ample dimensions. Compression ratio 6 : 1. Five-point bi-axial engine mounting on special rubber blocks. Cooling by pump and fan, controlled by by-pass thermostat. Carburettor fitted with thermostatic mixture control.

Dismantling for Decarbonising

Decarbonising and grinding-in the valves are essentially a garage job, owing to the fact that a block and tackle is required in order to remove

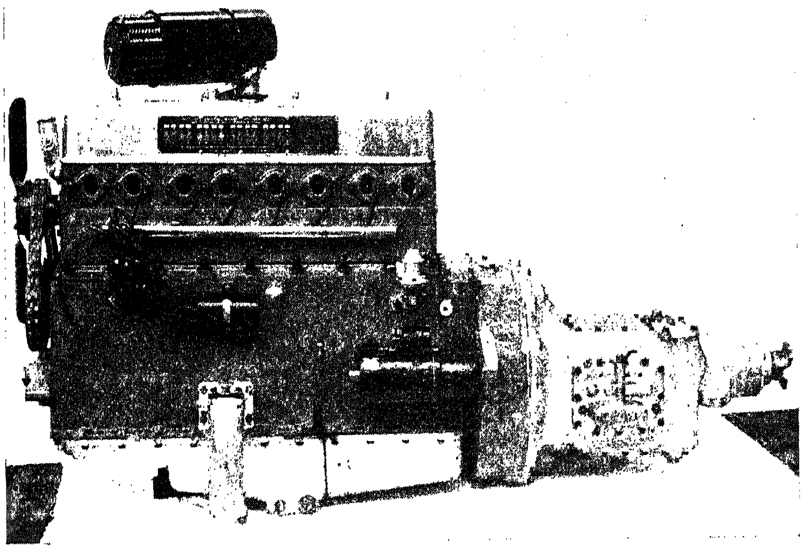


Fig. 1.—THE DAIMLER 3½-LITRE ENGINE

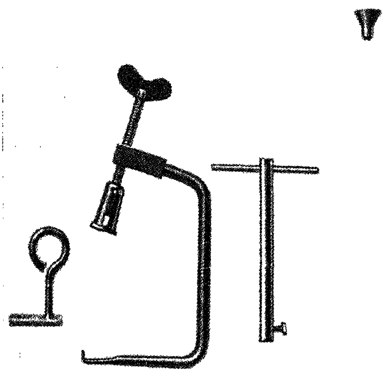


Fig. 2.—SPECIAL TOOLS

cylinder block. With the necessary tools and equipment it is quite a simple job, and if the following instructions are carried out no trouble should be experienced.

Having drained the water and removed bonnet, etc., disconnect and remove carburettor controls, delivery pipe from petrol pump, pipe from drip tray, pipes to carburettor, air silencer, and valve cover.

Remove oil pipe to rocker shaft, slacken fan-belt adjustment, and remove fan belt. Disconnect oil-feed pipe to fan, undo setscrews securing fan to cylinder block, and remove fan complete. Undo screws securing aluminium tube for high-tension leads, disconnect high-tension lead from distributor to coil, pull ends of high-tension leads from sparking plugs, and take off distributor cover. Remove sparking plugs.



Fig. 3.—REPLACING CYLINDER BLOCK (1)
Lower cylinder block carefully until pistons 4 and 5 begin to enter their bores.

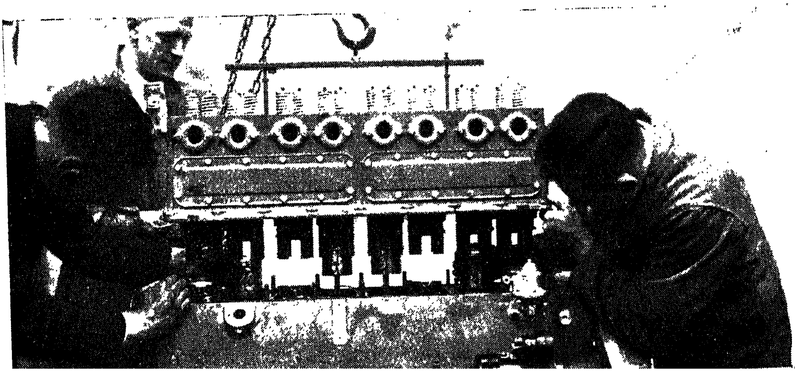


Fig. 4.—REPLACING CYLINDER BLOCK (2)

When all rings have entered cylinders 4 and 5, turn engine by hand, lowering block carefully at the same time, until pistons 2 and 7 commence to enter taper. Cease turning engine, and lower block until pistons 2 and 7 have entered cylinders.

Remove thermometer bulb from water-outlet branch and clips securing tubing ; bend tubing out of the way. Remove water connection between cylinder block and water pump.

Disconnect exhaust pipe from manifold, also automatic choke-control rod. Disconnect and remove exhaust and inlet manifolds.

Removing Cylinder Block

Undo cylinder-block holding-down nuts, attach special hooks (No. 1 of Fig. 2). The cylinder block must then be raised evenly and pro-

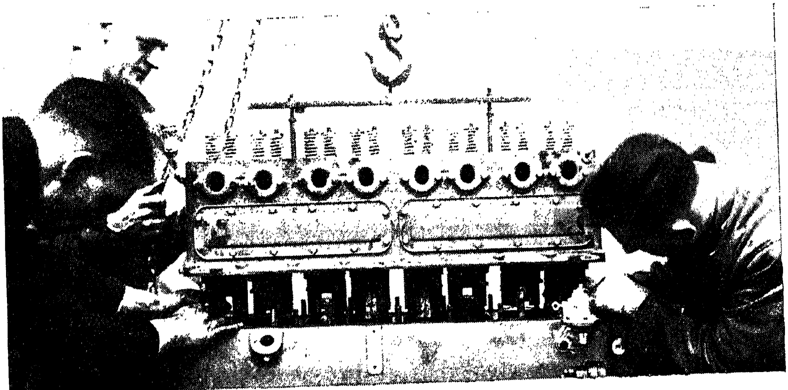


Fig. 5.—REPLACING CYLINDER BLOCK (3)

Continue to enter pistons 3 and 6, followed by pistons 1 and 8, into cylinders in the same way as described under Fig. 4.

gressively until pistons are clear of the bores. Do not allow the rods or pistons to fall against the crankcase.

Valves

To remove valves, slacken locknuts on rockers and undo adjusting screws to fullest extent, tilt rockers and remove push-rods. Mark the push-rods to ensure returning to original positions.

Using Tool No. 2 (Fig. 2) remove valves. Valve heads should be marked numbers 1 to 16, commencing with No. 1 nearest radiator.

Clean off valves and ports and grind-in, using Tool No. 4 to insert valve in guide, using Tool No. 3.

Replace valves, and do not forget to fit circlips. Clean off the top-joint surfaces of the crankcase, also bottom surface of cylinder block. Always fit new joint between block and crankcase. Place clean oil on pistons, and block is ready to reassemble.

Replacing Cylinder Block

Turn engine until pistons Nos. 4 and 5 are at top dead centre. Lower cylinder block carefully until pistons 4 and 5 begin to enter their bores (*see* Fig. 3).

The lowest portion of the cylinder bore has a gradual taper, which will allow easy entrance of the piston's rings without use of clamps.

When all rings have entered cylinders 4 and 5 turn engine by hand, lowering block carefully at the same time, until pistons 2 and 7 commence to enter taper (*see* Fig. 4). Cease timing engine and lower block until pistons 2 and 7 have entered cylinders.

Continue turning engine, lowering cylinder block at the same time, until pistons 3 and 6 commence to enter taper.

Cease turning engine and lower block until pistons 3 and 6 have entered cylinders.

Continue turning engine, lowering block until pistons 1 and 8 commence to enter taper (*see* Fig. 5).

Cease turning engine and lower block until pistons 1 and 8 have entered cylinders. Lower block on to crankcase, screw on holding-down nuts and reverse dismantling operations. If the various operations of fitting the block are carried out carefully, no difficulty should be experienced. The only possible way of breaking a piston ring is by trapping it outside its groove, in which case the piston will refuse to enter the bore. Thus, it is almost impossible to refit the block and be unaware of a broken ring.

When the engine is assembled, start up, and when thoroughly warmed up check over tappet clearances and all nuts, bolts, etc. This operation should be repeated after two hundred miles.

It may be noticed that the carburettor mixture is excessively rich when

idling, and difficult to adjust. Upon examination this trouble may be found to be due to carbon deposit on the barrels and butterfly. These parts should always be cleaned when engine is decarbonised, and also when rich idling is experienced.

Tappet Adjustment

Power and fuel consumption depend very largely on maintaining correct tappet clearances. Individual best tappet clearances all marked in thousandths of an inch are on a brass plate attached to the valve cover. A feeler gauge is provided in the tool kit, and correct adjustment requires a certain degree of skill.

Engine must be hot when clearances are checked and adjusted.

Check and adjust in the following manner: Turn the engine until valve No. 16 is fully opened, and proceed to check valve No. 1. The design of the camshaft is such that No. 16 valve *must* be on its lowest point (i.e. fully opened) when No. 1 valve is adjusted, otherwise correct clearance will not be obtained. Check the other clearances in a similar manner. With valve No. 15 fully open, check valve No. 2, and so on.

ADJUSTING ENGINES FOR MAXIMUM OUTPUT ON LOW-GRADE FUEL

By S. G. MUNDY, M.I.E.E., A.M.I.A.E., M.I.M.T.

ONE of the most serious difficulties experienced by war-time motorists is the loss of performance caused by the use of "pool" petrol. This is evidenced by difficulties of hard starting, poor acceleration, pinking, and increased petrol consumption.

These difficulties can be explained by the fact that the modern engine is designed for the use of a fuel with high anti-knock properties, and when this engine is used on low-grade fuel such as "pool" petrol, which has a comparatively low anti-knock value, it cannot give its normal performance. The adjustment of the carburettor, the fitting of new jets, or the cleaning of sparking plugs, cannot in themselves make any *real* difference; the use of compounds or "dopes" in the petrol is a mere palliative, and even if the performance does improve this is only temporary.

There is only one way in which an engine can be made to give its best performance on "pool" petrol, and that *is to adjust the engine for use on that petrol.*

What Adjustments are Needed

The adjustment of any engine for its maximum performance and economical running requires:

(1) An examination to ensure that the mechanical condition of the engine is satisfactory, and equally that the condition of such components as the battery, ignition coil, condenser, distributor, plugs, carburettor, etc., are satisfactory.

(2) An adjustment of those settings which vary with the condition of the car and the grade of petrol used.

(3) An adjustment of those settings which remain constant throughout the life of the car, to the recommended manufacturer's standards.

This examination and adjustment must be carried out completely and accurately, and in order to save time the work must be done systematically, proceeding by a proper process of elimination. The aim is to obtain the maximum over-all efficiency. This will result if the efficiency of all the individual components is brought up to a maximum. These components must be examined separately and each adjusted to its maxi-

mum efficiency before we can expect to obtain the maximum result of all components combined.

The examination of the engine can be divided into three divisions, namely :

(1) Mechanical condition.
(2) Electrical system (ignition).
(3) Carburation.

Providing proper instruments are available, an examination of these three divisions can be made without dismantling any components excepting the plugs, and with the use of the latest methods and equipment available the time required for the examination will not exceed an average of 20 minutes.

Mechanical Examination

A visual inspection to determine the mechanical condition of the engine is not practical, since it would necessitate dismantling and require considerable time. A sufficiently accurate examination can be made without dismantling and in a few minutes by using a vacuum gauge.

It is convenient, at the same time as the mechanical condition is examined, also to test the battery and starter.

The vacuum gauge is connected to any suitable point in the induction system, described on pp. 224–25 of Vol. IV.

A tong-test type of ammeter should be clipped around the battery to starter cable, and a moving-coil voltmeter reading 0–15 or 0–20 volts should be connected across the battery.

It is important completely to close the carburettor butterfly, and then, with the ignition rendered inoperative, the starter switch should be pressed. Three readings will be obtained, namely :

(1) Vacuum reading.
(2) Voltage of battery on starter load.
(3) Current consumption of starter.

The conclusions that can be drawn from these readings are dealt with in detail in Vol. IV (*see* pp. 221–34 and 305 and 306).

Ammeter Reading

The ammeter reading on a warm engine should be approximately 120–130 amps., according to the h.p. of the car. Any *serious* discrepancy suggests—

(1) Light loading due to a " sloppy " engine, causing a drop in the starter current.

(2) Faulty starter or starter circuit, causing a heavy current and low starter r.p.m.

(3) A faulty battery and consequent lack of power.

(1) will have been checked by the vacuum gauge in examining the mechanical condition of the engine.

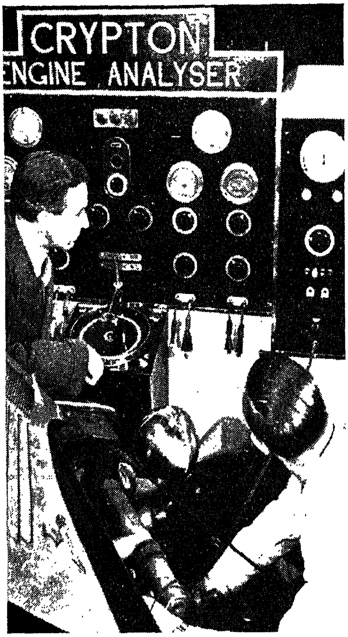


Fig. 1.—CHECKING EFFICIENCY OF CARBURETTOR BY VACUUM TEST WITH ENGINE RUNNING. (*Crypton Equipment, Ltd.*)

(2) and (3) can be checked by making special tests of the starter and battery circuit in accordance with details given in Vol. IV.

Voltage Reading

The reading obtained on the voltmeter should be not less than 9–10 volts for a 12-volt system, or $4\frac{1}{2}$–5 volts for a 6-volt system. If the reading is less than these figures, it suggests a defective battery, starter cables, or earth connection.

When carrying out the examination as a preliminary to making adjustments, the customer must, of course, be advised of any faulty conditions which the examination shows. It is very important that the battery and starter system is efficient, because an inefficient system must be compensated for, when the engine is finally started, by increased petrol.

Ignition Examination

The ignition system comprises the battery, contact breaker, induction coil, high-tension distributor, sparking plugs, and inter-connections. Since the efficiency of any internal-combustion engine is vitally dependent on the high-tension output to the plugs, and since all these components are responsible for providing the correct high-tension output to the plugs at the correct interval of time, obviously each component of the ignition system must not only be efficient, but must be adjusted to the finest limits of accuracy if the engine is to give its maximum efficiency.

The examination of the ignition system for the purpose of adjusting an engine to its maximum efficiency is not a question of finding ignition faults, but of determining the general efficiency of the system. It is relatively easy to find an ignition fault. It is by no means easy to adjust the complete system for fullest efficiency. This can be done only by making a careful test of all individual components, *and also* carefully checking and measuring the resultant high-tension output. This requires systematic analysis.

Resistance of Ignition Primary Circuit.—From Ohm's law, and knowing the applied voltage, we can—by measuring the current of the ignition primary circuit—determine its resistance. Since amperage is propor-

tionate to resistance, any variation in amperage indicates a variation in the resistance of the circuit which, if other than normal, must be corrected. For further details of this test, *see* p. 307, Vol. IV.

Checking Contact-breaker Efficiency.—The condition of contact-breaker points has a very important effect on engine performance and petrol consumption, and should be tested as described on p. 307, Vol. IV.

Distributor.—The distributor is one of the most important and, in many respects, the least-understood and most-neglected component on the car. The distributor must be dead right to get best performance. The correct way for thorough service is to remove the distributor and test it out on a test bench or syncroscope, making the necessary adjustments for automatic advance and retard, etc.

It is as well to appreciate the function of the distributor. Its purpose is to break the primary current at predetermined intervals, with a definite period of dwell. The latter is the period of time during which the points are closed. This period of time is determined by (*a*) the cam angle and (*b*) the maximum point opening on any cam.

It will be evident that if there is an incorrect gap setting or mechanical wear the result will be an inefficient spark, due to the result of incorrect wave form in the high-tension current produced in the secondary of the ignition coil, and also the possibility of a spark occurring at the wrong time (owing to possible mechanical wear). Up to the present time it has not been possible properly to check distributors *on the car*, but now under development is a new Stroboscopic method which gives any variation from the correct phase angle. This new development has not yet been commercially marketed, but any reader who is specially interested can obtain particulars by communicating with the Editor.

It is, however, possible to make a very fair check of the priod of dwell by using a voltmeter (*see* p. 308, Vol. IV). In the case of a four-cylinder car, where the points are open for the same period of time as they are closed, if a voltmeter is connected across the coil "C.B." terminal and earth—that is, across the contact points—the meter will read the mean value between zero with the points closed and the applied voltage with the points open. If the time periods are equal, the meter reading should obviously be 50 per cent. of the applied voltage. In practice, therefore, we should always connect a voltmeter across the contact-breaker points with the engine running (a suitable speed is approximately 750 r.p.m.), and ascertain that the meter reading is approximately half the battery voltage and is steady.

If the reading is high, it indicates that the contact-breaker points are wide; if the reading is low, that the points are too close; and if the reading is unsteady, that there is a mechanical distributor fault. A high reading may also be caused by the charging rate being too high, or loose, dirty, or

corroded connections in the charging circuit. A low reading may possibly be due to poor connections in the ignition low-tension circuit.

Condenser.—Condenser testing has always been a contentious subject. Obviously, condensers can be and are tested. It is necessary to know the leakage, impedance, and capacity, but—what is equally important—also the effects of heat and vibration. A portable tester will test leakage, impedance, and capacity.

A large proportion of car condensers break down due to faulty internal connection of the plates ; this connection may be good at the instant the condenser is tested, but subsequently prove faulty owing to vibration. Also, heat is an important factor, and all condensers should be tested hot. Therefore, for proper condenser testing, in addition to the testing of leakage, impedance, and capacity, a vibration and heating device is also strictly necessary.

Considering the problem from another angle, however, a faulty condenser will reduce the high-tension output, particularly at speed. If a standard ignition coil is taken and used with a contact breaker rotating at variable speeds, then, by substituting the condenser under test for a condenser known to be in good condition, a comparison can be obtained. In order to do this, however, *accurate measurement* of the high-tension output must be obtained. This can be provided for by using a suitable ammeter calibrated in milliamps and designed for use in a high-tension circuit. Such an ammeter will indicate the slightest inefficiency of the condenser, which can be tested on the car. The result of any tightening of screws can immediately be observed, and, since the condenser is warm by conduction from the engine, it is tested under service conditions. The effect of vibration can be easily checked by revving up the engine and then retesting.

Ignition Coil.—The ignition coil can be tested in the same way as the condenser by a measurement of the high-tension output on the micro-ammeter, a comparative test being made against the ignition coil on the car and a coil known to be in good condition.

A spark gap is used on conjunction with the high-tension ammeter both for condenser and coil testing, and this gap should preferably be of the "ball-gap" type (this design is largely used by the Air Ministry for aircraft-magneto testing, but has now been commercially developed for garage service).

High-tension Output to Plugs.—By using the spark gap the high-tension output to each plug can be tested by making a series connection between the plug lead and earth.

Sparking Plugs.—Having made certain that an adequate high-tension supply is being fed to each individual plug, the final point is to check that the plugs are themselves efficient, as described on pp. 309 and 311, Vol. IV.

A word of warning can be given at this point to those service mechanics

who, reading of the results obtained by wide plug gaps, open out standard plugs in the hope of getting improved performance. The secret of the high m.p.g. obtained by certain manufacturers who use wide plug gaps lies not in the plug gaps but in the design of the engine, particularly the induction system.

It can be stated that in practice plugs are replaced less frequently than they should be. Tests both in the U.S.A. and in this country have proved conclusively that plugs are not economical to use after ten thousand miles, and in every case where the mileage has exceeded this figure the owner should be advised to have a new set of plugs.

We have now completed both a mechanical and an electrical examination of the engine, which will have indicated the need for any special adjustments or service work which may be necessary and which the owner should have carried out if he wishes to obtain the maximum performance from his car. The work required may involve mechanical service such as decarbonising, the replacement of certain components such as plugs, condenser, ignition coil, etc., or any mechanical or electrical service which the examination made has shown to be necessary.

MAKING ADJUSTMENTS FOR MAXIMUM PERFORMANCE

We now come to the question of the adjustments which it is necessary to make in order to ensure that the engine shall give its maximum performance on " pool " petrol.

First Adjustment—the Carburettor

The first adjustment to consider is the carburettor. The carburettor is a device which controls the fuel intake to the cylinders. It is designed so that under normal conditions it will provide—

(1) A rich mixture for starting and slow running.
(2) A medium mixture for acceleration and hill climbing.
(3) A weaker mixture for high-speed " cruising."

These varying ratios are the result of mixture combustion obtained either by varying the jet size (mechanical type) or by having several jets (hydraulic type).

The correct fuel-air ratio depends on the grade of spirit, but, in general, it may be stated that 15 : 1 is common for petrol, 20 : 1 for benzole, and 9 : 1 for alcohol.

The performance of the car will materially depend upon the adjustment of the fuel-air ratio. If the mixture is weakened by up to 10 per cent., it will usually give a higher thermal efficiency, i.e. more m.p.g. If made up to 20 per cent. richer, it usually results in greater mean effective pressure at the cylinder head, giving better performance. One advantage is gained only at the expense of the other, and, since both are desirable, there must be a compromise.

It may be taken that commercial carburettors, as fitted to the modern

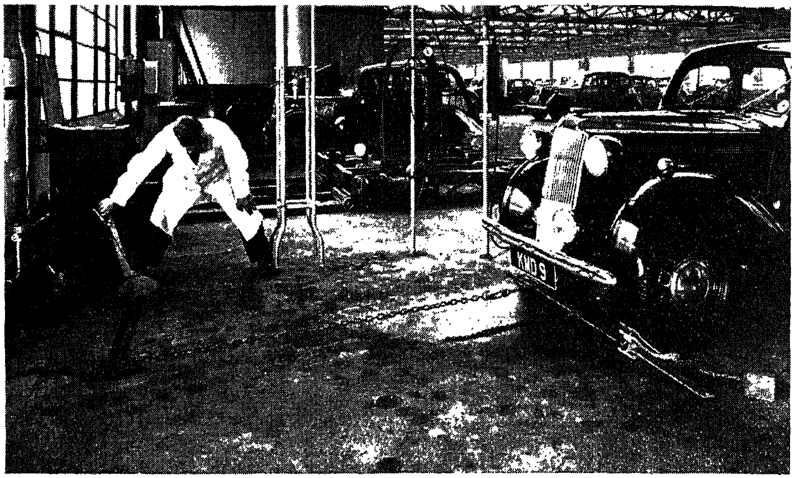


Fig. 2.—HIGHLY ACCURATE PETROL CONSUMPTION TESTS AND ADJUSTMENTS CAN BE MADE BY THE USE OF A BRAKE HORSE POWER TESTER, TOGETHER WITH A FLOWMETER AND AN EXHAUST-GAS ANALYSER

The above picture shows a car being located on a Heenan & Froud brake horse power tester, and Figs. 3 and 4 illustrate the equipment being used. (*By courtesy of Shaw & Kilburn, Ltd.*)

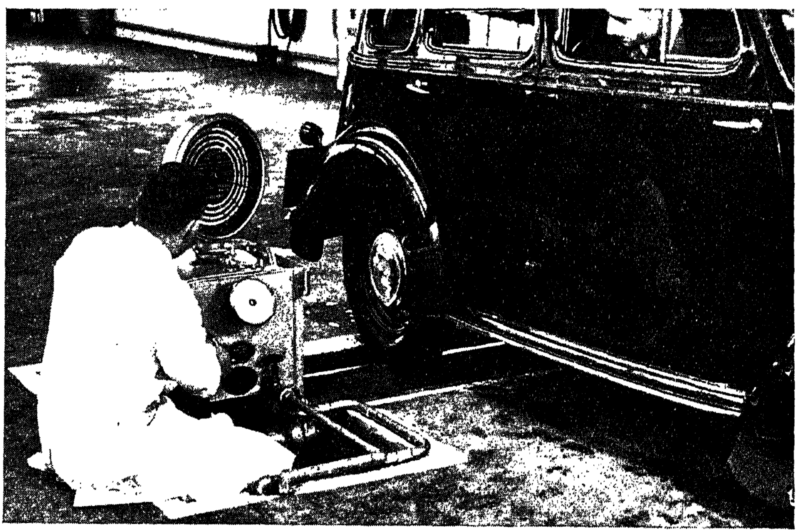


Fig. 3.—CAR HAVING BRAKE HORSE POWER TEST

;ear, being driven as on road at 30 m.p.h. (*see* speeds on machine, Fig. 4) ·ter brake being actuated by mechanic to cut speed to 30 m.p.h. (*By* *'burn Ltd.*)

car, are the result of considerable research, and that no major alterations to such carburettors are justified, except in special circumstances.

Consider exactly what happens in the carburettor—the mixture of air and petrol is drawn into the cylinders, where it is compressed and ignited, causing combustion to take place. Combustion is the phenomenon resulting from any reaction evolving heat. Oxygen supports combustion, and petrol, being composed mainly of carbon and hydrogen, is combustible. Theoretically, perfect combustion is that where exactly the right amount of air is present to combine with the petrol. In practice, this condition is never obtained, excess air being always supplied, which remains unused in the exhaust gas.

The combustion of carbon and oxygen produces carbon dioxide (CO_2) and carbon monoxide (CO). The latter gas is, of course, poisonous. Hydrogen and oxygen combine to form water.

It can be stated that combustion is complete when the CO content of the exhaust gas is at a minimum. Measurement of the CO content therefore provides a basis which will enable us to determine the efficiency of combustion—a matter of vital importance in adjusting carburation to suit " pool " petrol.

Hints on using the Exhaust-gas Analyser

The commercial instrument used to provide an analysis of the exhaust gas and to determine its CO content is an exhaust-gas analyser. This consists of a Wheatstone bridge, in one arm of which is a special conductor enclosed in a sealed sample of perfect gas. An example of the use of an exhaust-gas analyser is illustrated on pp. 328-31, Vol. IV.

The exhaust gas is passed over a similar conductor, and the galvanometer deflection consequent upon the varying resistances which occur with varying qualities of exhaust gas are indicated on a scale calibrated " normal," " rich," and " lean," or some equivalent calibration. The difficulty with an exhaust-gas analyser is to keep the loading and the throttle opening constant for a sufficient period of time to obtain an accurate reading. A sufficiently approximate indication can, however, be obtained, and in the hands of an operator who is prepared to be patient, excellent adjustments can be made by the use of an exhaust-gas analyser. The ideal is to use a b.h.p. tester, together with a flow meter, which enables a highly accurate adjustment to be obtained (*see* Figs. 4 and 5).

Adjusting the Carburettor on the Vacuum Gauge

It is, however, possible to get a very satisfactory adjustment using a vacuum gauge connected in the same way as for checking the mechanical condition of the engine (*see* Fig. 1). Alteration of the slow-running adjustment will result in a variation of the engine speed and, in consequence, of the vacuum reading. The object is to get the vacuum reading as high as possible, at the same time keeping it steady. If the throttle opening is

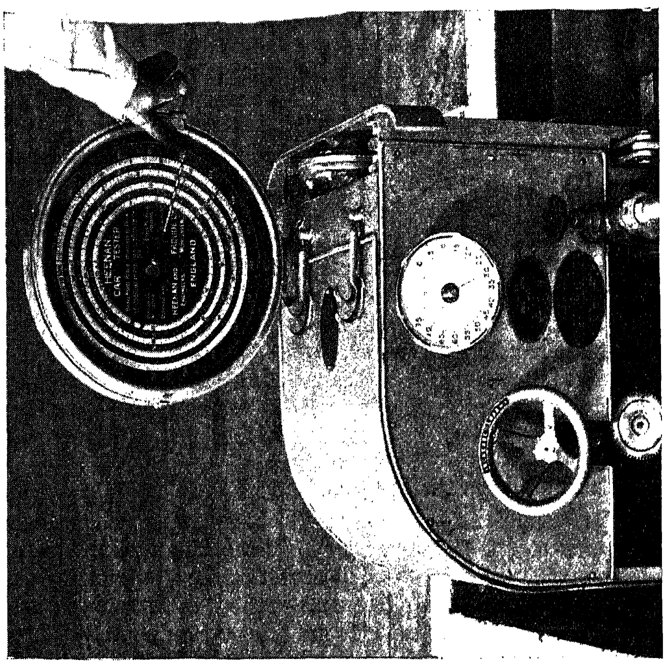


Fig. 4.—THE BRAKE HORSE POWER INDICATOR

Reading is taken on large dial. Reading shows 24 b.h.p. at 30 m.p.h., calculations not required. Readings are worked out on dial of instrument at speeds from 10–70 m.p.h. on different bands. (*By courtesy of Shaw & Kilburn, Ltd.*)

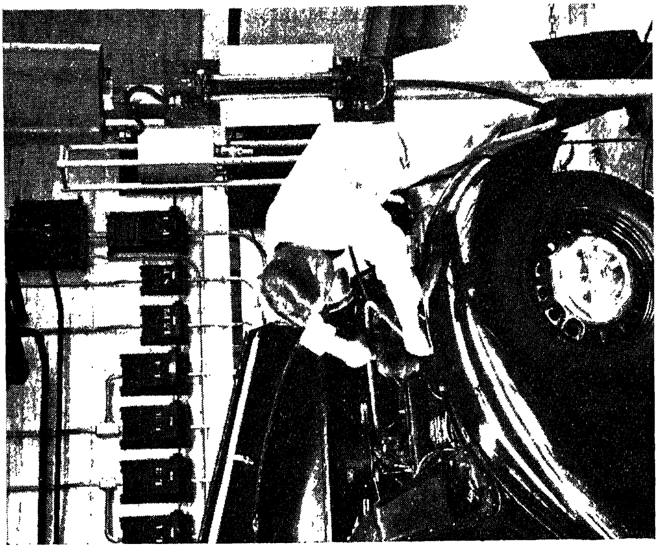


Fig. 5.—FITTING FLOW METER AND WATER-COOLING PIPES PRIOR TO PETROL-CONSUMPTION TESTS IN CONJUNCTION WITH A B.H.P. TESTER

The use of the Heenan & Froud b.h.p. tester is shown in the previous photographs. (*By courtesy of Shaw & Kilburn, Ltd.*)

set and the engine r.p.m. increased, the mixture is more effective. It will be found in practice that there is a range in the slow-running screw where the vacuum reading does not alter. The adjustment should be such that the mixture is as rich as possible without losing vacuum—in other words, keep on richening the mixture until the vacuum needle shows a tendency to drop.

The following points should be noted in connection with adjusting carburettors on the vacuum gauge :

(1) Any air leak into the induction system will give a high r.p.m. at idling speeds. If the throttle is completely shut down and the engine turned on the starter, the consequent vacuum reading will be low (8 in. or under). This test can be made to verify the possibility of air leaks.

(2) If a drain tube is fitted, the vacuum hose should be temporarily connected to it, when any blockage present will be evident. A drain tube should not, however, be used as a vacuum-point connection for adjustment purposes.

(3) If a strangler is fitted, make certain that it opens completely ; if the starting device is automatic, make certain that it returns to its seating.

(4) Always check the float level and make certain it is correct.

(5) If the slow running is obviously rich and cannot be adjusted satisfactorily, check the petrol-pump pressure. Other symptoms of trouble are black smoke from the exhaust and a strong smell of petrol when coasting downhill.

Adjusting Multiple Carburettors

The first thing is to ascertain that the suction over the jets is equal on all carburettors. Therefore, uncouple the throttles and close them completely. Check the starter vacuum reading, and then open one throttle slightly and take a second reading. The drop from the original will be proportionate to the throttle opening. Close this throttle again completely, counting the number of turns on the control screw. The next carburettor throttle should then be opened slightly, and the opening adjusted until the starter vacuum reading is the same as that obtained with the first throttle opening. If a third carburettor is fitted, repeat the process. In certain cases it is better to have a slightly higher air input on the middle carburettor, and the service mechanic will soon learn from experience that this is necessary. Having adjusted the throttle openings the engine should be run, and the individual slow-running jets adjusted as already described so that they each give the highest vacuum. The balance is tested by earthing the plugs corresponding to each carburettor in turn. The vacuum readings should be identical in each case.

A normal set of readings might be :

Starter vacuum with both throttles closed . .	17 in.
Starter vacuum with No. 1 throttle open . .	12 in.
Starter vacuum with No. 2 throttle open . .	12 in.
Running vacuum on both carburettors . .	17 in.
Plugs 1, 2, and 3 earthed	10 in.
Plugs 4, 5, and 6 earthed	10 in.

Adjustment for Load—for Maximum M.P.G.

Satisfactorily to adjust mixture on load can, from a practical point of view, be covered in most cases by a vacuum-gauge adjustment, because of the self-compensating effect of the carburettor. If something more definite is required, however, this can be done by a b.h.p. tester, a flow meter, and an exhaust-gas analyser. Since such a complete range of equipment is seldom available, road adjustment will in most cases be necessary. Smaller jets and a smaller choke tube will give greater economy, but the higher-speed performance will be correspondingly reduced, the low-speed acceleration being improved. It should, however, be noted that with the advent of " pool " petrol and the increased need of economy, certain carburettor manufacturers have produced a carburettor designed to give the most suitable possible characteristics.

Finally, it must be realised that there is no " rule-of-thumb " method of adjustment for carburettors. Reasonable skill and experience are essential. A point to be remembered, however, is that by knowing the condition of all other units, such as ignition etc., the results will depend on carburation only. This, of course, excludes mechanical trouble such as binding brakes, flat tyres, etc.

Ignition Timing

Having adjusted the carburettor, the final operation is ignition timing. As is known, the ignition must be capable of being advanced or retarded according to the loading of the car and the fuel used. If the ignition is too far advanced, " pinking " will occur, this being caused by combustion taking place too early, resulting in the piston at the top of its stroke leaving one cylinder wall and banging against the other. From the instant the spark occurs until combustion is complete there is a definite time-interval. This time-interval depends on the fuel—the air-fuel ratio and the combustion—$\frac{1}{1000}$ sec. may be taken as an indication. The shortest time-interval occurs when combustion is complete, and the time-interval increases as the mixture is strengthened or weakened, more especially the latter. Carried to excess in either direction the mixture will not ignite at all. The process is quickened by turbulence, but this is a question of design and not adjustment, although it should be noted that plugs will affect turbulence, and one should be certain that the correct plug is fitted.

Adjusting the Distributor Timing

When making carburettor adjustments at fast-idling speed, as already described, the distributor timing was not altered. The mixture was adjusted at a set throttle until the maximum output was obtained. Whatever mixture we have tested on (let us assume as weak as is compatible with starting and an even tick-over), this mixture will have a definite time of combustion. Therefore, we require the spark to occur at such a time before top dead centre that the full force of combustion is available at the correct crank angle. This will give the greatest power and the highest r.p.m. Assuming that the time of combustion is $\frac{1}{1000}$ sec. at tick-over speed, the spark will occur at, say, $\frac{1}{4}$ in. before top dead centre, and combustion will be complete near the commencement of the piston descent. To obtain this result the distributor is rotated until the ighest vacuum reading is obtainable. This will give us the correct ad- tment at the loading of the engine when the adjustment is made, but obviously the car, when on the road, will require a larger throttle opening to produce the same engine r.p.m. It has been found in practice that this can be achieved by retarding the ignition until the vacuum reading falls $\frac{1}{2}$ in. if a centrifugal control is fitted. Where a vacuum control is fitted the ignition is left at the maximum vacuum gauge position, since it will be automatically retarded under load.

Summary of Adjustments

Summarising the essentials of correct adjustments for maximum performance on low-grade petrol we are faced with the following :

1. It is essential firstly to check over the car to verify the mechanical condition of the engine and the condition of all electrical components.
2. This examination can be made very quickly and can be carried out completely by using simple tools and a systematic method.
3. Any service or the fitting of any replacements shown to be necessary as a result of the examination must be carried out, since unless this is done maximum performance cannot possibly be attained.
4. Certain adjustments must now be made and should include contact-breaker points, plug gaps, carburettor, and ignition timing. Contact-breaker points can be adjusted by voltmeter test; plug gaps by sparkmeter test; carburettor by vacuum gauge (with a subsequent road test if necessary), and ignition timing also by vacuum gauge with retardation of $\frac{1}{2}$ in. in the case of cars with centrifugal control to allow for road conditions.

If it is felt from the completeness of this article that considerable work is involved and considerable time required to carry out the examination and adjustments, this in practice is not so, provided the correct instruments are available in the form of a reliable ammeter, voltmeter, vacuum gauge, and sparkmeter.

Time required to make Adjustments

The average time for the examination is twenty minutes, or, including adjustments, about one hour. If the latest equipment is available—which includes more complete apparatus—the time can be reduced.

END OF VOLUME II